FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

## IN THIS ISSUE

Dietetic Foods from the Viewpoint of the Dietitian / *47*

The Functional Properties of the Egg White Proteins / *49*

Special Purpose Foods — Some Problems of Development / *53*

Sensory Test Methods. II. Effect of Previous Tests on Consumer Response to Foods / *56*

The Effect of Concentration on Quality of Frozen Orange Juice with Particular Reference to 58.5° and 42° Brix Products. I. Chemical and Physiological Aspects / *60*

The Effect of Concentration on Quality of Frozen Orange Juice with Particular Reference to 58.5° and 42° Brix Products. II. Bacteriological Aspects / *64*

Detection of Washed Eggs with Ultraviolet Light / *67*

Properties of Stored Frozen Orange Concentrate Observed by Differential Cloud Determination / *70*

Transportation of Frozen Citrus Concentrates and Other Frozen Foods / *74*

Citrus By-Products and Derivatives — An Introductory Survey / *78*

Amount and Character of Connective Tissue as It Relates to Tenderness in Beef Muscle / *80*

A Laboratory Fruit-Essence Recovery Unit / *87*

Consumer Wine-Preference Methodology Studies at California Fairs / *90*

Measuring the Size Compliance of Foods / *94*

The Effects of Iodized Salt in Processed Fruits and Vegetables / *103*

The Effect of Aureomycin Treatment on the Shelf Life of Fresh Poultry Meat / *107*

Notes and Letters / *109*

Affairs of the Institute / *2*

Pages 47-110

February, 1955 Volume 9, Number 2

# GET ACQUAINTED WITH SORBITOL...

## a wholesome food ingredient with exceptional properties

Sorbitol possesses unusual qualities as a food ingredient. Its ability to improve storage life by stabilizing moisture and retaining softness, its non-volatile nature, mildly sweet flavor and established nutritive properties have encouraged widespread examination by food technologists. It has been found to give improved characteristics to a variety of food products.

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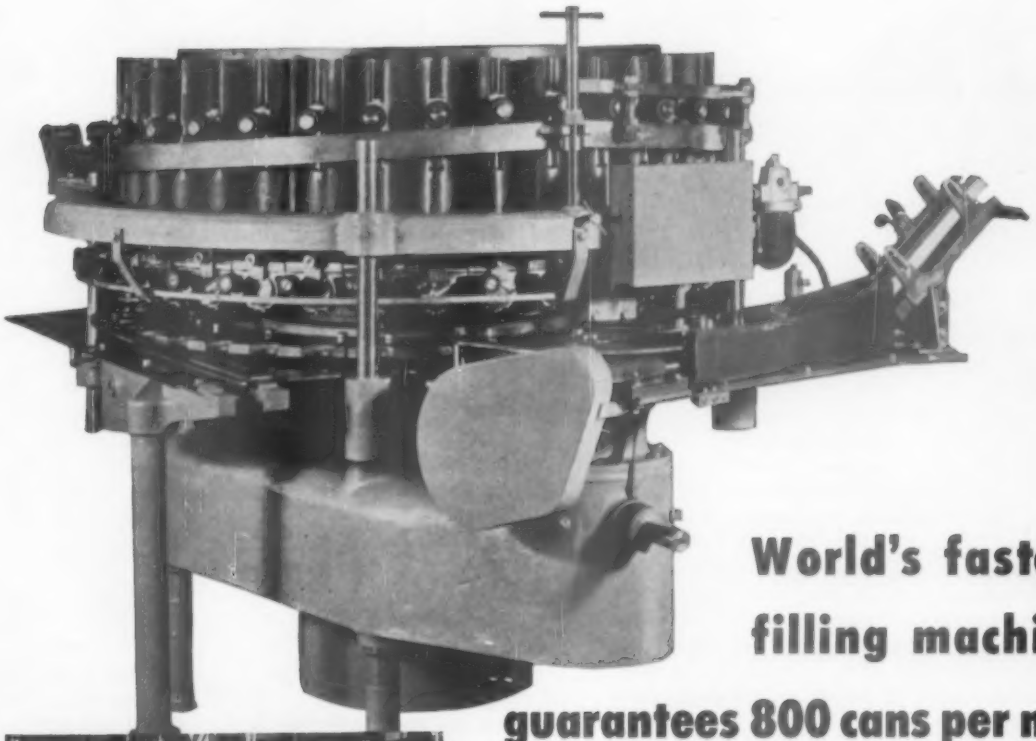
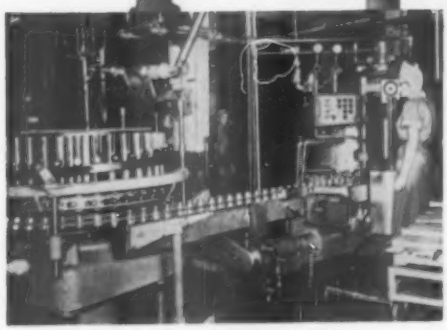
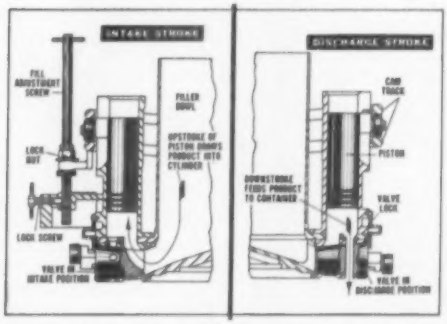


# World's fastest filling machine guarantees 800 cans per minute

## *New Pfaudler 35 Station Piston Filler!*



More than 800 cans of baby food a minute are filled at H. J. Heinz Co., Leamington, Ontario, with this new Pfaudler 35 station filler. Filler, world's fastest, was developed at Heinz's request by The Pfaudler Co. with cooperation of Continental Can Co.




Filling action is illustrated above. The diagrams show position of operating parts on opposite sides of the machine.

On a single machine, you can fill a container of your product for every man, woman and child in a city the size of Riverside, California (population 46,764)—in less than 1 hour!

That gives you some idea of the production advantages of the new Pfaudler 35 piston filler. It's the world's fastest. We *guarantee* it will fill 800 cans per minute, in all sizes up to 16 oz. And we've seen it go higher than 1000!

Breath-taking production speeds on the new Pfaudler 35 are easily regulated with these special features:

**Magnetic brake** stops the filler within .2 second after you apply it, and is synchronized with a similar high-speed brake on the closing machine.

**Electrically controlled** no-can-no-fill mechanism is activated pneumatically for split-second spill prevention.

**Adjustable tilt**—Cans ride on a track which tilts them for filling. Angle of tilt adjusts to speed of filling and product.

**Precise filling**—In most cases, we can guarantee an accurate fill within ±1/10 oz.

Maintenance of the machine is simple. You have only 3 points on the entire filler to lubricate by hand. Bearings in the base and all gears are automatically lubricated. Cleaning is also easy, because only the valves and pistons need be removed, and you don't need any tools to do the job.

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Make us prove to you that the Pfaudler 35 will actually pay for itself in lower production costs, higher production. Write for our latest bulletin today.

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**THE PFAUDLER CO., ROCHESTER 3, N.Y.**

# Affairs of the Institute

Annual Meeting Bulletin Board
Dr. William V. Cruess
Regional News
Personnel
Books
Recently Elected Members of IFT
Selected Abstracts
Food Industry Topics
Future Dates for Food Technologists

## Annual Meeting Bulletin Board

**Progress Notes on the Program.** The Program Committee is now working on the final layout for the June 12-16 meeting. The initial call for papers and suggestions for discussion groups indicates many new developments of interest to all food technologists. Abstract forms are now being sent to those presenting papers. This is being done to facilitate editorial work and at the same time give each contributor maximum time to complete his finished abstract. Since these final abstracts are not due until February 1, there is still time to submit titles and abstracts. The program committee is anxious to provide the best program ever at any IFT meeting. If you have a paper to present or if there is a problem or topic which should be discussed at the meeting, simply indicate your paper title or discussion topic to:

F. E. Deatherage
Department of Agricultural Biochemistry
The Ohio State University
Columbus 10, Ohio

You will then receive abstract forms to be completed and returned.

Already the program is well past the formative stage and holds forth much promise. It includes subjects of significant importance and speakers of outstanding ability with national and international prominence. The program should be a challenge to Food Technologists to turn out in large number at Columbus, this next June 12 through 16.

The *Meat Session,* with W. J. Shannon presiding, scheduled for Monday afternoon, June 13 should be interesting, judging from the good number of papers at hand. A session on *Sensory Testing* is also scheduled for the same afternoon and has been provided in response to what appears to be popular demand.

The Tuesday morning sessions contribute further to the variety and diversification of interests that an IFT program needs to provide. Charles H. Mahoney's session on Vegetables, George F. Stewart's on *Poultry and Eggs,* the session on *Microbiology* under J. C. Ayres and a *Packaging* Session arranged by R. A. Farrell, are all shaping up as replete with timely and pertinent material.

On Tuesday afternoon there will be at least three headline sessions. The session on *Food Engineering and Process Control,* headed by Frank K. Lawler, should be outstanding, judging from the interest demonstrated in this area at Los Angeles and since. With all of the developments and expansion taking place in this field, H. P. Schmitt's session on *Frozen Foods* should be a most timely one. B. L. Oser has arranged a top-notch session on the *Functional Value of Food Additives,* a subject that enjoys a high priority rating among the interests of Food Technologists.

There will be no let-up in the pace nor any let-down of interest on the Wednesday program. In the morning will be featured a session on *Fruits* with R. D. Gerwe in charge and a *Quality Control* symposium led by Roy E. Morse. The afternoon will be high-lighted by sessions on *Canning and Processing* in charge of Charles L. Smith and *Fats and Oils* presided over by H. J. Deuel.

Interspersed throughout the program will be groups of contributed and research papers. A symposium on *Radiation Sterilization* is being arranged for by R. G. Tischer. Z. I. Kertesz is arranging for discussion groups. There will be an array of prominent speakers on Monday morning, June 13, and the program also includes presentations by the winners of the Appert Medal, The Babcock-Hart Award and the Food Engineering Award.

The Women's Program being arranged by Professor Inez Prudent is so enticing that a number of local IFT members in the know have expressed a desire to attend these festivities instead of the technical program. However, IFT members must wear skirts for these events.

The Entertainment Committee is arranging three outstanding events for all. The oxen are growing, the bathing queens are already beautiful, and you have a big treat coming up in Columbus, June 12-16.

### Tours

**Ohio State University.** Visitors will have an opportunity to see the beautiful new student union building on Tuesday night, June 14, when they attend the Appert Award banquet. They will also see the stadium and natatorium during the ox roast and entertainment on Monday evening, June 13.

The tour of the principal food technology laboratories scheduled for Thursday, June 16, will include the newly acquired Ohio University Research Center, which will house a central laboratory and facilities for cooperative research, the Horticultural laboratories located in the Horticultural and Forestry building, the Chemical Engineering laboratories in the Chemistry building and the Departments of Agricultural Biochemistry and Dairy Technology located in the Agricultural laboratories building. The department of Dairy Technology maintains a modern dairy plant.

**Battelle Memorial Institute, 505 King Ave.** The world's largest private non-profit research organization. Founded in 1929. Has approxiately 2200 scientists, technicians, and other personnel working on diverse projects of both a fundamental and practical nature. Fields of research endeavor include essentially all phases and types of engineering, chemistry, physics, electronics, nucleonics, engineering economics, graphic arts, and agricultural sciences. In addition to the Columbus research center, the Institute maintains two laboratories and several offices in foreign countries.

**Capital City Products Co., 525 W. First Ave.** Manufacturer and processor of fatty foods. Refining, hydrogenation and processing of crude cottonseed, corn, and soya oils. Market covers eastern two-thirds of the United States. Principal products include "Dixie" margarine, "King's Taste" mayonnaise and shortening, and "BBS" shortenings for bakery use.

**Buckeye Potato Chip Co., 2689 E. Fifth Ave.** Manufacturer of potato chips, canned shoestring potatoes, and packaged popped corn. A small modern specialized food plant servicing central Ohio. Potato chipping capacity of about 1000 lbs. per hour.

**Kroger Baking Co., 457 Cleveland Ave.** One of 14 bakeries operated by the Kroger Co. A large modern bakery that produces breads, cakes, crackers and cookies. The Columbus plant is one of the two Kroger plants that bake crackers and cookies.

(Continued on page 5)

## Who's Looking After the Diet Shopper?

# Sell her—keep selling her with your SUCARYL® sweetened line

*She can't (or shouldn't) take sugar-sweetened products!*
*She knows* SUCARYL*—she's used it in her home.*
*She'll buy—actually shop for—your* SUCARYL*-sweetened line.*

It's about time someone got around to the diet shopper. She wants one thing—*sweetness without calories*—and she'll go blocks out of her way to get it. Give her a product sweetened with SUCARYL, and you'll grab one of the livest new markets in the country.

SUCARYL, you know, provides sweetness—real, clean, sugar-like sweetness—without the bitterness or clinging, sharp taste of other synthetic sweeteners. It's a different substance entirely—Cyclamate—and it will hold up throughout your entire processing operation. With SUCARYL, your product can become a valuable adjunct to a properly-controlled diet.

We've written a book about SUCARYL, especially for you. Tells you all you need to know about getting in the market. Drop us a line. But do it quick. The market is new, and now is the time to get your brand established.

Write: Chemical Sales Division,
Abbott Laboratories, North Chicago. Abbott

*Cyclamate, Abbott

# WHY SHOULD THE VITAMIN C CONTENT OF FRUIT AND VEGETABLE JUICES BE STANDARDIZED?

*Because nutrition reports disclose that—*

- **Vitamin C deficiencies exist throughout the country***
- **Scurvy has not disappeared from the United States***

**Proof of deficiencies among adults and children.** You should know these facts!* Diet surveys from Maine and Vermont, New York, Illinois, New Mexico, Oregon, West Virginia, and Texas show a definite pattern of inadequate vitamin C intake. These studies covered grade school and high school children, college men and women.

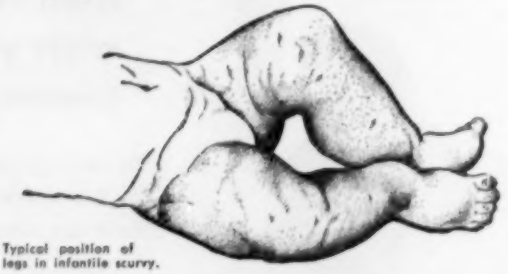
Spongy, swollen gums symptomatic of scurvy.

From these studies* of dietary habits and physical conditions there is considerable proof that many of the children and adults covered by survey have actual, physical symptoms of vitamin C deficiency.

**Infantile scurvy.** Scurvy* occurs, even today, among infants who are artificially fed. Fortunately the disease may be cured by the administration of vitamin C. How much more sensible it is to prevent it by supplying these bottle-fed infants with the daily allowance of 30 milligrams of vitamin C as recommended by the Food and Nutrition Board of the National Research Council for children under one year of age.

Symptoms of infantile scurvy are fretfulness and fear of being touched.

These bottle-fed infants, unless receiving a pediatric prescription containing vitamin C, are largely dependent on supplemental ascorbic acid which they receive from fruit or vegetable juices. Unless fortified with vitamin C many of the processed juices may not supply these babies with adequate quantities of this essential element.



Typical position of legs in infantile scurvy.

**What can be done?** Because of the increasing evidence that American diets are deficient in vitamin C, leading nutrition experts believe that processed fruit and vegetable juices, on which the public is so reliant for its supply of this necessary vitamin, should contain the "Vital Ingredient."

The Vital Ingredient of any processed fruit or vegetable juice is a *dependable* and *adequate* supply of vitamin C. You can give your juice this ingredient by *standardizing its vitamin C content*. The processing is simple and the new low cost of ascorbic acid makes juice standardization more attractive than ever.

With ascorbic acid available *by the tons* at extremely modest cost fruit and vegetable juices can have a standardized vitamin C content for the better protection of the nation's health and well-being.

*Statements are based on documented reports. References on request.

Illustrations after photographs in The Vitamins in Medicine by Bicknell and Prescott, Third Edition, published by Grune & Stratton, Inc., New York.

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## ANNUAL MEETING BULLETIN BOARD

(Continued from page 2)

Types of crackers made are soda, oyster, and Graham. Soda cracker capacity is approximately 2200 lbs. per hour. Some 30 to 35 varieties of cookies are made in this plant. A quality control laboratory is maintained for continuous inspection of raw materials and finished products. The tour will be confined primarily to the cracker and cookie division of the bakery and the laboratory.

**M & R Dietetic Laboratories, Inc., 625 Cleveland Ave.** Manufacturer of concentrated and dehydrated special food products made primarily from milk. Plant operations include concentration, spray drying, ion exchanging, and modern packaging. Plant in Columbus manufactures "Pream" and "Par-T-Kreme," two different types of dehydrated cream products, "Ten-B-Low" and "Colac," two different types of concentrated ice cream mixes, and powdered whole milk. Modern plant at Sturgis, Michigan manufactures "Similac," a substitute mother's milk. Trade area includes all of the U. S. and many foreign countries. Tour will include the plant and laboratories.

**Westinghouse Electric Corp., Electric Appliance Div., 300 Philipi Road.** The Nation's largest refrigerator plant. A brand new industrial plant opened in 1954. Manufactures home refrigerators and freezers. Peak production capacity is 4000 major appliances per day. Tour will cover much of the plant, the quality testing facilities, and the splendid auditiorium and display room.

**Omar Bakeries, 408 Sheldon Ave.** A new and very modern plant that produces breads, doughnuts, rolls, cakes, and pies. Operates one of the world's largest automatic bread ovens that turns out 7200 loaves of bread per hour. Doughnuts made at the rate of 720 dozen per hour. Operates 419 home delivery routes in the Columbus area.

**August Wagner Breweries, Inc., 605 S. Front St.** Columbus' only operating brewery. Has been in continuous—yes, continuous—operation since 1905. Products are two lager beers, "Gambrinus" and "Augustiner."

**Hotel Accommodations.** Columbus is a fast growing city and has always been a popular location for national conventions because of its many fine hotels. It is the third largest convention city in the United States. Our IFT Convention to be held here beginning the 12th of June should be one of the finest and most interesting our organization has ever had.

The executive committee has selected the Deshler Hilton and the Neil House as the convention hotels. The hotels are both famous for their courteous and efficient service. The guest can always be assured of a comfortable and enjoyable visit.

The Deshler Hilton, which is to be our headquarters, is in the process of being redecorated, remodeled and air-conditioned. The hotel has already opened a lovely new sky room on the 16th floor with glass walls on three sides giving the visitors a panoramic view of the city. A popular local radio show emanates there every day during the luncheon hour. Visiting celebrities are interviewed and there is music and light patter combined to give an entertaining informal program.

Our other hotel, the Neil House, is known for its fine floor shows and dancing nightly in the beautiful Town and Country Room. Their meeting rooms and ballrooms are among the finest in the country.

These hotels are located in the heart of Columbus directly across the street from the State Capitol and are accessible to all the stores and theaters in the downtown area. *Hotel reservation blanks will be mailed to all members approximately three months prior to the convention time.*


# FOOD TECHNOLOGY

**Published Monthly by the Institute of Food Technologists**



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Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

**Subscription Rates:** For members the cost of subscription is included in the annual dues. Non-members: domestic, $8.50 per year; foreign, $10.00 per year. Single and back copies: domestic, $1.00; foreign, $1.25.

**Advertising Representatives:** *Eastern:* Duncan Macpherson, 700 S. Washington Square, Philadelphia 6, Pa. *Midwestern:* Prendergast and Minahan, 168 N. Michigan Avenue, Chicago 1. *West Coast:* William A. Ayres Company, 233 Sansome Street, San Francisco 4, California.

**Publication Office**

The Garrard Press,
119 West Park Avenue, Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.


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Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.

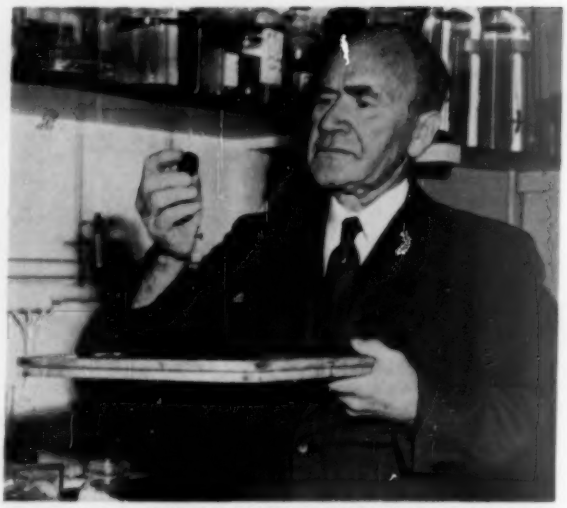
## *Dr. William V. Cruess*

### — His Career Parallels the Growth of Food Technology and Research

WILLIAM V. CRUESS, pioneer in food technology and former president of the Institute of Food Technologists, reached retirement age last July at the University of California.

But instead of retiring to his six-acre fram near Berkeley and giving full time to his hobbies of fishing, photography, and pack mule trips in the High Sierra, Dr. Cruess accepted a University appointment for the 1954-55 academic year.

And so he continues in the "laboratory harness," supervising work which in the past has touched many of the fruit and vegetable crops grown in California and has resulted in some 500 articles, bulletins, circulars, and books, of which the best-known is the textbook "Commercial Fruit and Vegetable Products."



DR. WILLIAM V. CRUESS EXAMINES A SPECIMEN OF NEWLY DRIED PRUNES—OBJECT OF MUCH RESEARCH DURING LONG SERVICE.

#### SOME FOOD TECHNOLOGY "FIRSTS"

Born in San Miguel, California, the great-grandson of a Forty-Niner, Dr. Cruess was graduated from the University of California in 1911. He began work there immediately as a fermentologist. In 1916 he instituted what he believes was the first food technology course in the United States. Shortly thereafter he set up the University's first organized research in the canning, drying, and freezing of fruits and vegetables. This made possible discoveries on which the horticultural products industry depended many years later.

Dr. Cruess become the first chairman of the division of food technology at the University in 1935, holding that post until 1948 when he gave up his administrative duties to have more time for teaching and research. He was succeeded by a former student, Dr. Emil M. Mrak. Dr. Mrak described Dr. Cruess's early work in the following words:

"The early work done by Professor Cruess on factors influencing the quality of wine had a tremendous effect on the improvement of California wine. . . . The very foundation of the fruit dehydration industry was laid in the old Department of Fruit Products and Food Technology by Professors A. W. Christie and W. V. Cruess. . . . It was the introduction of the air-blast tunnel dehydrator with the control of temperature, humidity, and air flow that enabled the tremendous industrial development of the fruit dehydration industry."

#### CONTRIBUTIONS TO THE ECONOMY OF THE HORTICULTURAL PRODUCTS INDUSTRY

Other highlights of Dr. Cruess's career to date include: teaching prune growers the profitability of dehydration as compared to sun drying; introducing enamel-lined cans to retain the color of canned ripe olive; modifying pickling so that olives could be sterilized as required by law without damaging their quality; adapting Spanish methods of green olive pickling to California conditions; promotion of pasteurization to

(Continued on page 8)

**FOOD RESEARCH HEADQUARTERS—Headquarters for the University of California's food research program are located in this clean-lined building on the Davis campus. The two-story section contains staff offices, well-equipped research laboratories, and the Consumer Acceptance Laboratory. The one-story section (right) is the Food Processing Laboratory, containing some $150 thousand worth of processing equipment for teaching and research on methods to improve California's processed foods. The teaching-classroom wing is at the left. Dr. Cruess urged the construction of such a facility as early as 1918; he saw the realization of his urgent efforts in 1951.**

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• You protect edible oils from undesirable off-flavor, aroma and color when you prevent oxidation with Pfizer Citric Acid. That's because Pfizer Citric Acid added to the fat or oil in the deodorizer inactivates the iron, copper and other metals which cause rancidity.

Citric Acid has long been the metal scavenger preferred by the oil and fat industry. In fact, new Standards of Identity for dressings—salad, mayonnaise and french—permit the use of Citric to replace part of the vinegar in the formula. The benefits gained are two-fold: the citric cuts material costs and sequesters out trace metals which cause rancidity.

Keep edible oils fresh longer with Citric Acid! For more information, write Pfizer's Technical Service Department.

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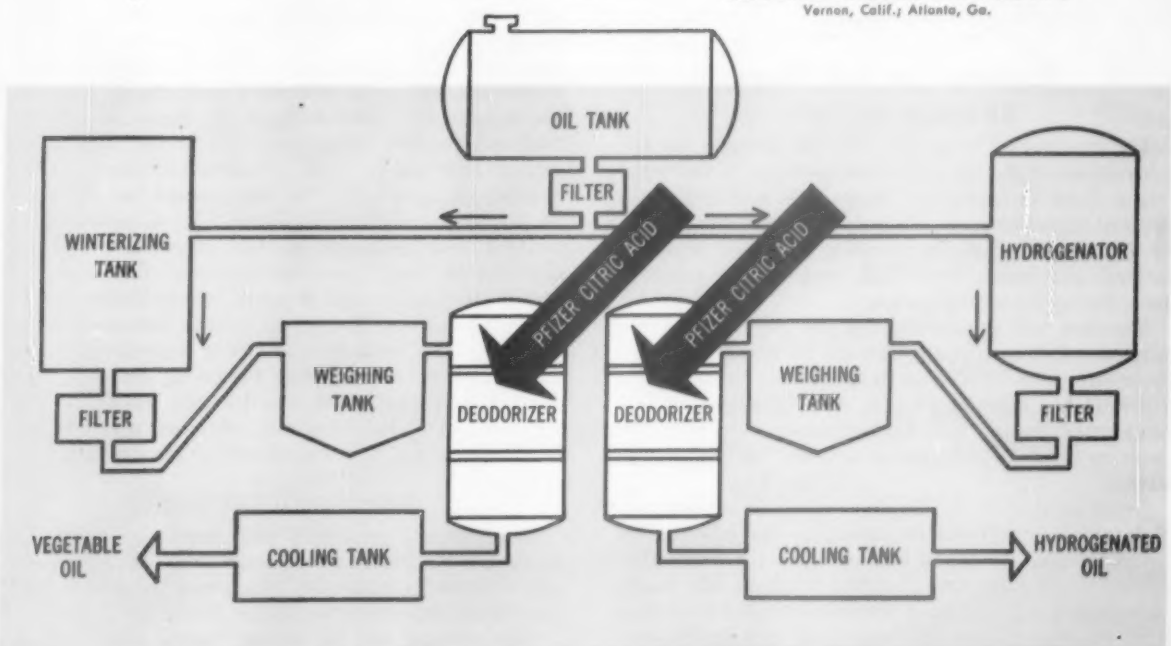


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## DR. WILLIAM V. CRUESS

(Continued from page 6)

prevent spoilage during ripe pickling; instituting flash pasteurization and de-aeration of citrus juices to inactivate enzymes and minimize flavor change; and finally, as an "after-hours study," extensive experiments aimed at increasing the use of surplus fruits through new combinations such as dried fruits in candies and cereals, raisin pie filling, etc. In World Wars I and II, Dr. Cruess and associates worked with the Army Quartermaster Corps on vegetable dehydration. From this work came a widely-used bulletin on the subject which the Army used as a handbook.

### HONORS AND REWARDS

As a trailblazer in the field of food technology, Dr. Cruess has received honors in the form of decorations and offices in professional associations. A charter member of IFT, he founded a section in northern California and promoted one in southern California. He won the first Nicolas Appert award for research in food technology in 1942. In 1944 he was national president of IFT. He belongs to several honor societies and he has been decorated by the French Government.

But the reward he considers the most satisfying of all was to see the culmination in 1951 of a project he first began urging in 1918: the superbly-equipped, million-dollar Food Technology Building on the Davis campus of the University.

## Regional Section News

### CHICAGO SECTION

The meeting in November was the occasion for another tribute to the immediate past president of the Institute of Food Technologists. Bert Clark, who served the national organization so well, was presented with a gavel by Stan Brockington. In accepting this gavel from the national association, Bert Clark reviewed the progress made during his administration.

Members and guests enjoyed the new meeting arrangements. Dinner in the Chicago Room was preceded by an enjoyable social hour in the Illinois Room, where a private bar served cocktails. After dinner, members commented that the "hike" via elevators to the assembly room on the third floor was a welcome "seventh inning stretch."

Guest speaker, F. C. Lewis, a visitor from England, discussed the problems of packaging canned foods in Great Britain. Technical liaison officer for Metal Box Company, Overseas Ltd., London, England, Mr. Lewis stated that Great Britain is not too interested in electrolytic tin. It is anxious to keep trade with its colonies, and as a result only one-fourth of the tin plate produced is electrolytic.

Canning of red fruits—strawberries, raspberries, and especially red plums—is a major preoccupation of the canning industry. Use of added color is allowed in great Britain in canned fruits so that maintaining color quality is not much of a problem. Color is also used to maintain the color of canned peas, both for fresh and dry soaked. Flat sours which were once a problem have been eliminated by the use of in-plant chlorination procedures. The baby food industry is of no consequence in Great Britain even though advertised rather extensively. Regarding beverages, beer in cans is not an important factor at the present time.

Frozen foods have not made too much headway as many homes have no refrigeration and green vegetables are available nearly the year around.

### DIXIE SECTION

The December meeting was held at the University of Georgia with the Department of Food Technology, Connor Hall, as the assembly point. After a tour of the Dairy Department, the group had dinner in Dawson Hall. A series of papers followed by discussion comprised the technical program. Papers were presented on the following topics: "Coliform Bacteria in Strawberries" by J. O. Mundt, G. A. Shuey, and I. E. McCarty of the University of Tennessee, Knoxville, "Polarographic Analyses of Peroxides in Fats and Oils," by C. M. Balkcom, Norris Candy Co., and "Moisture Vapor Absorption of Potato Chips and Similar Foods," by Barney Hilton, H. W. Lay and Co.

### LOS ANGELES SECTION

The regular December meeting was held at the Rodger Young Auditorium Wednesday, December 1. A bumper crop of Scifters, sweethearts, and wives turned out to hear retiring chairman Dr. M. S. Dunn, head of bio-chemistry at U. C. L. A., comment on a selected 200 of 1500 color photographs taken by him on his six-months tour of Europe last year—1953, that is. In addition to remarks about hotel food, Dr. Dunn spoke of the kind and quantity (often minimal) of the food of the natives, particularly of the peasants, and discussed the methods of agriculture. He also showed the effects of the war, from destruction of buildings to saddening of children, and mentioned the lack of sanitary facilities and heat in many European countries. His slides included many landscapes or breath-taking beauty, works of art, old castles, famous cathedrals, universities and professors, and examples of some marvellously conceived modern architecture. Following this delightful entertainment, the gavel was formally passed to Ray Lindquist of Rexall Drug Co., who then presented the other officers for 1955 and adjourned the meeting.

### MARYLAND SECTION

Seventy-eight members and guests attended the December Meeting of the Maryland Section of the Institute of Food Technologists which was held at the Stafford Hotel, Baltimore, on Friday, December 10, 1954.

This meeting was the annual "ladies' night" of this section and a gala time for all was provided for by our hospitality chairman, Dick LeForge. The members and their guests were treated to cocktails, were served a delicious meal and then participated in the drawing for door prizes which were provided by processing companies represented in the Section. Favors were distributed to all and the assembled group heard a fine talk by Dr. H. L. Sipple, Executive Secretary of the

(Continued on page 10)

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## REGIONAL SECTION NEWS

(Continued from page 8)

Nutrition Research Foundation, Inc. His subject was "Nutrition Education — Opportunity and Responsibility."

Dr. Sipple discussed the lack of knowledge of nutrition on the part of the average American and how frequently this ignorance is exploited by quacks and food faddists. He urged all professional people to do their best to acquaint the people in their communities with sound, factual, nutrition information so that the country as a whole could prosper from better health which results from good nutrition education.

A question-and-answer period followed Dr. Sipple's formal presentation, and even the "guests" were quick to seize the opportunity to discuss nutrition with so eminently qualified a speaker.

The following officers have been elected by the Maryland Section to serve for the calendar year 1955:

Chairman: LeRoy V. Strasburger, Strasburger and Siegel, 1403 Eutaw Place, Baltimore 17, Md.
Vice-Chairman: William J. Hart, Jr., John H. Dulany & Son, Inc., Fruitland, Md.
Secretary: William A. Feild, 120 Melvin Avenue, Baltimore 28, Md.
Treasurer: Richard L. Hall, McCormick and Co., Inc., Baltimore 2, Md.
Councillors: H. Walter Kuhl, McCormick and Co., Inc., Baltimore 2, Md.; Dr. Howard Reynolds, Bureau of Human Nutrition and Home Economics, Beltsville Research Center, Beltsville, Md.

## MOHAWK VALLEY SECTION NEWS

The following is a recapitulation of the 1954 program:

*January.* Mr. Allen H. Saul of the Beech-Nut Packing Company was guest speaker. His interesting discussion on coffee was illustrated with movies: "Challenge to Coffee in 1954" and "Good Things Happen Over Coffee."

*February.* Dr. D. A. Theokas, General Ice Cream Corporation, Schenectady, N. Y., presented a splendid talk, "The Romance of the Ice Cream Industry" which was also illustrated with a film "As New York Grows."

*April.* Dr. Mary Hughes, Refined Syrups and Sugars, Inc., was guest speaker for the meeting. Her talk, "The Liquid Sugar Industry Today" was most enlightening and proved very enjoyable.

*May.* "Food Technology Ramblings" was the topic of the guest speaker, Dr. Carl Fellers, Department of Food Technology, University of Massachusetts. Many items of interest were presented in an excellent talk.

*October.* Dr. Jos. W. E. Harrisson, Director of La-Wall and Harrisson Laboratories, spoke on "Food Adulteration and Additives." The subject of his talk was very timely and significant.

*December.* "Problems Related to Radiation Sterilization" was the subject of a talk by Dr. W. D. Bellamy, General Electric Research Laboratory. All enjoyed this very interesting talk.

**1955 Officers**

Chairman: Dr. Theodore Irmiter, Div. of Chr. Hansen's Lab., Little Falls, N. Y.
Vice-Chairman: Michael E. DeBenedictis, Beech-Nut Packing Company, Canajoharie, N. Y.
Corresponding Secretary: Henry W. Ballou, Beech-Nut Packing Company, Canajoharie, N. Y.
Recording Secretary: Mary Jean Bartlett, Beech-Nut Packing Company, Canajoharie, N. Y.

## NORTHERN CALIFORNIA SECTION

The Section held its Annual Meeting on December 2 at the Western Regional Research Laboratory, Albany, California. Sixteen papers were presented and subject and authors are listed below:

1. *Starchy Cereal Thickening Agents for Canned Food Products.*
   John Gorton Davis, Joyce H. Anderson and Helen L. Hanson
2. *Some Preliminary Observations on Freezing of Bread.*
   Dale K. Mecham, James W. Pence and Thomas M. Lubisich
3. *A Rapid Photoelectric Method for Measuring a Color Characteristic of Yellow Sweet Corn.*
   H. C. Lukens, K. J. Palmer and C. H. Kunsman
4. *Objective Tests Reflecting Time-Temperature History of Frozen Fruit.*
   D. G. Greadagni, C. C. Nimmo and E. F. Janson
5. *Pectin Changes Occurring During the Softening of Brined Cherries.*
   R. W. McCready
6. *New Tools for the Isolation and Determination of Food Constituents.*
   J. W. Corse and K. P. Dimick
7. *Experimental Production of Spray-Dried Tomato Powder.*
   M. E. Lazar and Francis Wong
8. *Recent Trends in Potato Processing.*
   R. L. Olson
9. *The Thermal Resistance of Bacterial Spores—Recent Developments.*
   J. C. Lewis
10. *Observations on Acid-Tolerant Thermophlic Anaerobes.*
    R. N. Getchell, C. P. Collier and C. T. Townsend
11. *An Objective Test For Maturity of Canned Apricots and Peaches.*
    M. S. Nury, F. C. Lamb and L. D. Lewis
12. *Diastase Content of Honey.*
    John E. Schade
13. *Bacteria Associated with Zapatera Spoilage in Olives.*
    T. Kawatomari and Reese H. Vaughn
14. *Quality in Canned Pears.*
    Sherman Leonard, B. S. Luh and L. L. Claypool
15. *Acceptability Tests on Wines.*
    Harold Berg, Ferrer Filipello and Marion Simone
16. *Engineering Problems in Freeze-Drying of Meat.*
    J. C. Harper

William L. Presser, Dean of the Law School, University of California, addressed the meeting before the papers were given, answering pertinent questions put to him by the members.

F. P. Wehrlick, International Basic Economy Corp., followed the papers with a talk about "feeding problems in under-developed countries."

Bernard Feinberg was the dinner speaker and his topic: "The Food Technologist and the Formicidae." ("The ants are a people not strong, yet they prepare their meat in the summer.")

Presiding officers during the day's session were G. Mackinney, H. K. Burr, and H. J. Phaff.

Speaker for the January, 1955, meeting is Dr. Ernest Guenther of Fritzsche Brothers, Inc., New York. He will be speaking about essential oils, of course, and will be showing colored movies taken by himself within the last two years in Europe and North Africa.

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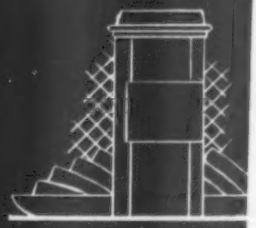

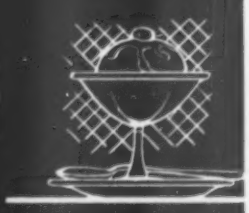

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*Isn't good taste the one consideration*
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*We believe our years of specialization*
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*For that reason, we'd like to suggest this:*
*If you do want extra flavor advantage*
*on the selling side of your product, come to FRITZSCHE . . .*
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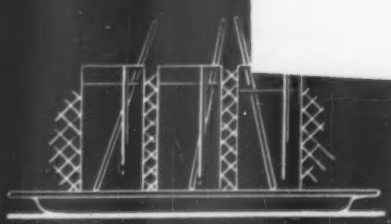

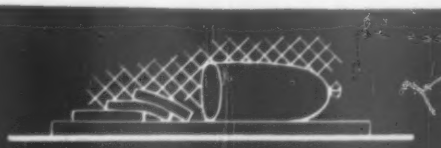

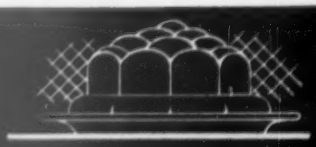

## REGIONAL SECTION NEWS

(Continued from page 10)

### PHILADELPHIA SECTION

The Philadelphia Section met December 7 at Drexel Institute. Over a hundred members and guests were present to celebrate our annual ladies' night. Every person present at the dinner received a large collection of gifts, donated by various local food industries.

The guest speaker was Dr. A. A. Schaal, Director of the Good Housekeeping Bureau, who spoke on "Food Trends and Consumer Protection." Dr. Schaal discussed the work of the Good Housekeeping Bureau in investigating and testing advertised food products for safety, accuracy of labeling, and fulfillment of purpose.

Among the food trends noted were the tremendous expansion in the production and sale of prepared baking mixes, and the phenomenal increase in the variety of frozen foods available to the public. Dehydrated and partially dehydrated foods were discussed, and the various types and uses of dietary foods were described. A question and answer period concluded the meeting.

### ST. LOUIS SECTION

This Section is cooperating with the College of Agriculture, University of Missouri, in sponsoring the Third Annual Food Technology Course, March 18 and 19, 1955. The course will be held in the Memorial Student Union, University of Missouri, Columbia. Reservations can be placed with C. M. Harold, Jr., c/o Anheuser-Busch, Inc., 721 Pestalozzi St., St. Louis. The general theme of this Short Course will be Food Additives. The program is not complete at this date, but we do have several outstanding speakers committed to appear on the program. Such outstanding authorities as Dr. K. G. Weckel, University of Wisconsin; Dr. C. E. Gross, John Morrell and Company; Dr. B. L. O'dell, University of Missouri; Dr. Paul Logue, Monsanto Chemical Company; Dr. H. E. O. Heineman, Pet Milk Company; Dr. G. K. Parman, Hoffman-LaRoche, Inc.; M. R. Johnston and R. L. Henrickson, University of Missouri.

### PHI TAU SIGMA

Coincidentally with the first anniversary of Phi Tau Sigma, the national food science honor society founded in Amherst, Mass., December 1, 1953, the University of Massachusetts Chapter of the Society, elected its officers for the year 1955. Elected president was Maynard A. Steinberg; vice president, Enio Feliciotti; treasurer, Rauno A. Lampi; Secretary, Tilford D. Miller; and national councilor, Dr. F. John Francis. Dr. Arthur S. Levine was elected to a two-year term as national councilor earlier this year. Retiring officers are Dr. Irving S. Fagerson, president; Miss Elizabeth Elbert, vice president; Professor Kirby M. Hayes, secretary; Maynard A. Steinberg, treasurer; and Pericles Markakis, councilor.

Three members of the University of Massachusetts' Faculty were elected to membership in the Society this Fall. They are: Dr. Anne W. Wertz, Research Professor of Nutrition; Dr. Denzel J. Hankinson, Head of the Dairy Industry Department and Dr. William S. Mueller, Associate Research Professor of Dairy Industry.

### PERSONNEL

Dr. L. E. Clifcorn, Director, Research Division, Continental Can Co., was recently elected vice president of the Agricultural Research Institute.

Gerald A. Fitzgerald, recently returned from Iran, where he was food industry adviser to the Government of Iran, has joined Donald K. Tressler and Associates, Westport, Connecticut, as vice president and general manager. The firm is substantially expanding its consultation services.

Dr. Clarence F. Schmidt, of Continental Can Company's Metal Division, Research and Development Department, presented the I. M. Lewis lecture before the Texas Branch of the Society of American Bacteriologists in Austin, Texas, on Friday, December 3rd. In his discussion of "Problems in the Study of Sporulation by Members of the Genus *Bacillus*," Dr. Schmidt reviewed recent studies of sporulation, and, by presentation of original data, illustrated the problems involved in the study and interpretation of the sporulation phenomena from a physiological standpoint.

Recently at an Open House Celebration in Chicago of The Griffith Laboratories, Inc., Dr. Lloyd A. Hall, Technical Director of the company, was one of four employees honored for 25 years service and presented with gifts by the President, Mr. Carroll L. Griffith.

Dr. Lawrence Rosner of the Laboratory of Vitamin Technology, Inc. has been reelected Chairman of the Animal Nutrition Research Council.

## Books

Advances in Food Research, Vol. V. Edited by E. M. Mrak and G. F. Stewart. 538 pp. includes both an author and a subject index for this volume as well as a table of contents for the previous four volumes. Academic Press, Inc., N. Y., N. Y., 1954. $11.50.

The fifth volume of *Advances* adds another significant contribution to the literature pertaining to foods. Seven subjects are discussed in this volume: Oxidative Rancidity and Discoloration in Meat, Betty M. Watts; The Chemistry of the Sugar-Sulfite Reaction and Its Relationship to Food Problems, Harry Gehman and Elizabeth M. Osman; The Chemistry and Technology of the Pretreatment and Preservation of Fruit and Vegetable Products with Sulfur Dioxide and Sulfites, M. A. Joslyn and J. B. S. Braverman; Statistical Methods in Food Research, B. Ostle and Robert G. Tischer; Flavonoid Compounds in Foods, E. C. Bate-Smith; The Color Problem in Foods, G. MacKinney and C. O. Chichester; Composition of Wines. I. Organic Constituents, Maynard A. Amerine.

Five of the seven reviews deal with their selected topics from a chemical standpoint. One of the remaining articles is concerned with the principles of sampling, design, and analysis, while the other discusses the measurement of color in several selected foods.

The review by Watts clarifies and integrates the literature of the oxidative changes in meats in a concise

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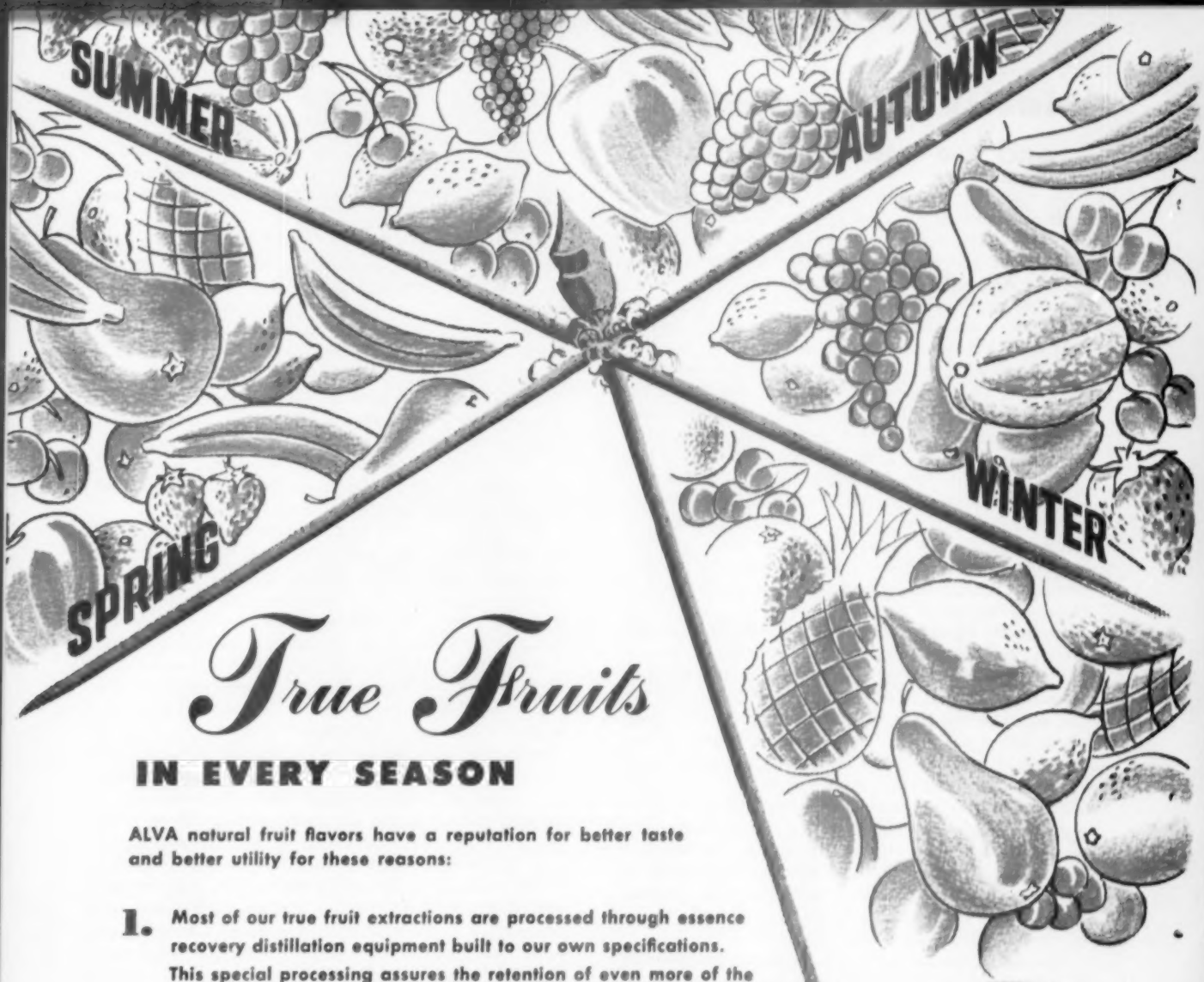


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**ALVA natural fruit flavors have a reputation for better taste and better utility for these reasons:**

1. **Most of our true fruit extractions are processed through essence recovery distillation equipment built to our own specifications. This special processing assures the retention of even more of the light fugitive esters so difficult to hold in normal extraction procedures.**

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**ALVA true fruit flavors are ideal for every use, and the ALVA laboratories are eager to help with recommendations and samples for every true fruit problem.**

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## Distilled monoglycerides and the anatomy of fluff

Anybody with a commercial interest in icings, biscuit fillings, or shortenings for such products has but to give us the word and we shall send him samples of three kinds of *Myverol® Distilled Monoglycerides—Type 18-00, Type 18-40,* and *Type 18-85.*

The idea would be for him to try out what proportions of which type do the best job of enhancing the creaming characteristics of the particular fats he wants to use. Put more broadly, how much of which lets his fat entrap and firmly hold the most sugar solution and air—the almost fully saturated *18-00,* the largely unsaturated *18-85,* or the intermediate *18-40?* All three are equally recognized for utter wholesomeness. The choice depends on the ratio between animal and vegetable fats employed, the creaming time permitted, the other ingredients of the mix, processing temperature, and the particular set of conditions likely to beset the product between blending vessel and final triumphal descent down the esophagus.

The doctrine preached here is not that Myverol monoglycerides are the most powerful emulsifiers that money can buy. On the contrary, too thorough emulsification defeats the purpose of the icing and filling maker. He does not want the finest attainable dispersion of aqueous phase into lipid phase. He wants the course of the emulsification arrested and frozen at a relatively early stage when there is still a goodly volume of air to contribute fluffiness. He wants this microstructure to have a certain mechanical strength, not too much and certainly not too little. Of macrostructure he wants a minimum, of course, so that emulsification must be advanced enough to justify the pleasant words "creamy smoothness." All in all, a fine balance that the monoglycerides appear best fitted to provide.

The difference between monoglyceride preparations in general and the molecularly distilled type we make is largely one of cost. Strange as it may seem, the highly purified Myverol kind costs less to use than mono-di reaction mixtures. This, we admit, is hard to believe. The only way to prove it is to run some experiments with our samples and put down a few figures on paper. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

*distillers of monoglycerides made from natural fats and oils*

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(Continued from page 12)

but comprehensive manner. She does a remarkably good job of presenting the current status of information which relates to the heme-catalyzed oxidation of unsaturated fats in meats.

Gehman & Osman and Joslyn & Braverman have presented companion articles dealing with the use of sulfites in the food industries and their effect on foods. While one might expect much duplication of information in these reviews, such is not the case since the handling of the subject matter by the two groups of workers differs considerably. In introducing the topic of browning, Gehman and Osman do not distinguish the enzymatic browning from other types. This reviewer doubts that the three general types of browning reactions—carbonyl-amino, caramelization, and enzyme-catalyzed oxidations—are so well-known to food technologists that delineation is unnecessary.

The article by Ostle and Tischer goes a long way to bridge the gap in knowledge existing between a small segment of workers in the field and the much larger numbers of research workers who would benefit from the employment of statistical techniques in interpreting data relating to the broad area of food quality evaluation. Your reviewer agrees with the principle proposed by these writers that the application of statistical method to quality control of foods has not been sufficiently exploited. Ostle and Tischer select a number of pertinent examples to illustrate the use of the basic statistical concepts such as analysis of variance, regression, correlation, analysis of covariance, and other techniques. Probably owing to the size of the article (98 pp.), discussion is restricted primarily to tests of significance; only incidental mention is made of estimation problems. If the uninitiated wishes to obtain a more complete general picture of possible uses of statistical methods in food research, it would be wise for him to read an additional review such as that by Eisenhart and Wilson (*Bacteriological Reviews,* **7,** 57-137, 1943) in order to extend and complement his knowledge of best procedures for estimating populations.

The review of the flavonoid compounds in foods by Bate-Smith relates not only to their general properties and distribution but to the genetic situation which pertains in fruits and vegetables. The author of the article has selected several excellent illustrative examples to show the role of these natural food pigments in food stability.

Since MacKinney and Chichester's article interprets the effects of pigments on the appearances of foods, it is an appropriate sequel to Bate-Smith's review relating to pigment chemistry. MacKinney and Chichester present some theoretical considerations which must be taken into account in order to obtain instrumental reliability in evaluating color. They point out certain advantages and limitations in the operational condition imposed in using various instruments. Also, they indicate some of the problems encountered in the measuring of color in certain specific food commodities.

One cannot help but respect the scholarly manner Amerine has used in surveying studies relating to the composition of wines. Despite the fact that he restricts

(Continued on page 16)

The vitamin A unit was originally defined in terms of what it took to start an A-starved rat growing again. Though long ago spectrophotometric methods of measurement took over, the liver storage type of bio-assay has its utility.

DPi will be happy to supply food laboratories with copies of its recently published "Simplified Procedure for Extraction and Determination of Vitamin A in Rat Liver."

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## BOOKS

(Continued from page 14)

his review to the organic chemical constituents of wines, he utilizes 1006 references.

The wide coverage and the excellent material provided by the several reviews presented in this volume insure the interest of food technologists. It is a pleasure to recommend the fifth volume of *Advances* to most branches of the food field; the book should find a place of esteem on the reference shelf.

JOHN C. AYRES
Ames, Iowa

LA CONSERVATION PAR LE FROID DES DENRÉES D'ORIGINE VÉGÉTALE, by Roger Ulrich, Director of the Biological Laboratory of the Refrigeration Research Station of Bellevue, France. One of a series of volumes called *Encyclopedie du Froid*, published under the Direction of Prof. Maurice Piettre. 330 pages with 155 figures. Librairie J.-B. Bailliére et Fils, Paris, 1954.

In his introduction, the author reviews briefly the progress of modern refrigration research in France and abroad, calling attention to remarkable progress in a number of countries. In France, he says, uses of low temperature for food preservation have not had the systematic investigation they have had elsewhere and the present volume undertakes a general review of the subject from sources chiefly in the English and German languages. The volume is divided into 12 main sections. The first two report biological and physiological studies on refrigerated vegetable substances and the third reviews practical conclusions from such studies. The five following sections are concerned with optimal conditions under refrigeration for the preservation of specific vegetables, fruits and manufactured foods and beverages. The ninth section deals with quick freezing and the tenth with "cryoconcentration" and "cryodessiccation." These two terms suggest adoption in English—with a slight change in spelling of the latter to "cryodesiccation."

This publication is a comprehensive, well-organized review. Undoubtedly, it will facilitate research and development in the refrigeration of perishable foods in France.

RUSSELL T. PRESCOTT
Albany, California

CHERRIES AND CHERRY PRODUCTS. By Roy E. Marshall. Volume V of ECONOMIC CROPS SERIES, edited by Z. I. Kertesz. Interscience Publishers, Inc., 1954, 283 pages and indexes, 41 illus., 27 tables, price $8.50.

Dr. Marshall's book brings together for the first time a wealth of information concerning all aspects of the production and utilization of cherries. The scope of this book reflects the author's wide research experience in both the horticultural and technological phases of the cherry industry. Because of his wide personal acquaintance in both the sweet cherry and red cherry industries, he is able to include a great deal of valuable information that has not been available heretofore in printed form.

To discuss both the sweet cherry and the red cherry in one volume would appear to be a most difficult assignment, since the two crops differ considerably in areas of production, cultural practices, and methods of utilization. Dr. Marshall has succeeded in presenting the differences and similarities of both crops in a clear and concise manner.

The origin and history of the cherry is presented briefly but adequately. Chapter II discusses the economic background of the cherry industry, and includes much interesting information gathered from various sources. The chapter dealing with the structural development of the cherry fruit is clear and supported with well chosen illustrations. Three chapters are devoted to the discussion of environmental and cultural factors affecting cherry production. The chemical and physiological changes in cherries during growth; maturation, and post-harvest handling are discussed in relationship to the characteristics of fruit for fresh use and for processing. Processed products are adequately discussed under the headings of canning, freezing, brined products, cherry juice, and dehydration. The final chapter is a valuable appendix listing the present standards and grades for cherries and cherry products.

This book performs a valuable service by assembling and summarizing the widely scattered literature of 300 scientists in the various fields relating to the production and utilization of cherries in North America. Food technologists are not alone in the benefits to be derived from having this volume at their command, for horticulturists, plant pathologists, and physiologists will find here much useful and interesting information.

CLAUDE H. HILLS
Philadelphia, Pennsylvania

CATALYSIS. Vol. I. FUNDAMENTAL PRINCIPLES (pt. 1) Paul H. Emmett Ed., Reinhold, New York, 1954. 394 pp. Illus. $10.00.

Although catalysis has developed historically as an art, the last thirty years have seen a gradually increasing application of systematic researches with the result that now a science of catalysis is emerging. With this in mind, Paul H. Emmett is editing an unspecified number of volumes dealing with practical and theoretical aspects of the general field of catalysis, but not including enzymes. Attention is focused on the catalysts and catalytic reactions and not on the engineering or economic characteristics of the process.

The present volume includes 3 chapters by Keith J. Laidler, entitled Chemisorption; Kinetic Laws in Surface Catalysis; and The Absolute Rates of Surface Reactions. Other chapters have been prepared by Herman E. Ries, Jr., Physical Adsorption; Paul H. Emmett, Measurements of the Surface Area of Solid Catalysts; W. B. Innes, Catalyst Carriers, Promoters, Accelerators, Poisons and Inhibitors; F. G. Ciapetta and C. J. Plank, Catalyst Preparation and P. W. Selwood, Magnetism and Catalysis. This volume includes a subject and author index.

The detailed exposition on physical adsorption, chemisorption, and kinetics of surface catalysis makes this volume particularly useful to those investigators of food stuffs who are interested in the catalytic effects of metal surfaces on the changes occurring during the

(Continued on page 18)

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*by* FIRMENICH

*gives finer flavor...*
*greater sales appeal...*
*to your products*

You get the direct and authentic reproduction of raspberries in their full perfection in Raspberry Flavor by Firmenich. For Firmenich took fully ripe raspberries, freshly severed from the stem, captured their delicate and fugitive flavor, and by original research reconstructed it in all its significant and desirable components. Firmenich Raspberry comes to you as a precise and potent flavor material of the utmost purity and stability to enhance the flavor of your products and to make them more attractive to your customers.

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## BOOKS

(Continued from page 16)

processing and storing of foods. Since later volumes will deal with oxidation and hydrogenation reactions, further interest by food technologists in this series is expected.

ERNEST SONDHEIMER
Geneva, New York

### Book Notes at Random

That food technologists can write in the essay vein as well as in the conventional technical manner is evident in two short books recently submitted to the Books Column. The first of these, THE ART OF FULL LIVING by Ted Lair, is available at the Vantage Press, Inc., New York, price $2.50. It is devoted to a modern application of the Socratic precept "Know thyself." The second book, *A Devotion to Nutrition*, is by Frederick Hoelzel. Mr. Hoelzel has studied the effects of fasting, using himself as test subject, and reports an improvement in both mental and physical health. The book furnishes autobiographical comment of much interest in connection with the fasting ordeals described. This, too, is a Vantage Press book.

* * *

Dr. M. A. Joslyn of the University of California Department of Food Technology, at Berkeley, has called attention to an article of outstanding interest—J. D. Mountfield's "SOME ASPECTS OF EDUCATION IN FOOD TECHNOLOGY," which appeared in *Chemistry and Industry* in 1953 (pages 931-936 of the 1953 volume). In the University of California publication, *Idea and Experiment, A University at Work*, Volume IV, No. 2, for December 1954, Dr. Joslyn gives his own views of the role of technological research and makes a plea for a type of training that will enable the technologist to use "pure science to solve problems arising from his practical concern" and to direct "attention to gaps in our basic knowledge."

* * *

Recent appearances in the series entitled "Surveys of Progress on Military Subsistence Problems," issued until recently by the National Academy of Sciences National Research Council and jointly sponsored by the Advisory Board on Qm. Research and Development (Committee on Foods) and the Qm. Food and Container Institute for the Armed Forces, include THE STABILITY OF DEHYDRATED EGGS, THE QUALITY AND STABILITY OF CANNED MEATS, NUTRITION UNDER CLIMATIC STRESS, AND FOOD ACCEPTANCE TESTING METHODOLOGY. These well-printed brochures are available to qualified scientists at the Quartermaster Food and Container Institute, 1819 West Pershing Road, Chicago 9, Illinois.

* * *

The YEARBOOK OF FOOD AND AGRICULTURAL STATISTICS for 1953, Volume 7, Part 1, (Production) is available at the Columbia University Press, International Documents Service, 2960 Broadway, New York 27, New York. The price is $3.50. This comprehensive study was prepared under the direction of the Food and Agriculture Organization of the United Nations.

* * *

### Addendum

The American edition of *Bread* by Lord Horder *et al.* (reviewed in the November issue) is published by The Macmillan Company, New York, N. Y. The price is $3.75.

# Selected Abstracts*

## ANALYTICAL METHODS

**A new method for the determination of gelatin.**

KASHIWADA, I. K., AND KAKIMOTO, D. *Bull. Japan. Soc. Sci. Fisheries, 18,* 203-7 (1952); *Food Sci. Abstr., 26,* No. 2328 (1954).

A new method is described for the quant. sepn. of gelatin from nitrogenous compds. of lower mol. wt., using the Folin-Wu precipitant.

## BIOLOGICAL SCIENCES

### BIOCHEMISTRY

**Application of a quantitative method of peptide analysis to the N-terminal sequence of lysozyme.**

DEFONTAINE, D., AND FOX, S. W. *J. Am. Chem. Soc., 76,* 3701-3 (1954).

The microbiol. phenylthiohydantoin subtractive method peptide analysis has been applied to the terminal aminoid tripeptide residue of chicken egg lysozyme, without discernible alteration of the rest of the mol. The sequence is shown to be L-lysyl-L-valyl-L-phenylalanyl-, which includes the configurational designations for the first time. Further evaluation of the quant. method of peptide analysis is presented.

**The biochemical causes of lecithin breakdown in egg-containing alimentary pastes. I. New experiments and the detection of a lecithin-splitting enzyme in long-keeping egg products.**

ACKER, L., DIEMAIR, W., AND JAGER, R. *Z. Lebensm.-Untersuch. u-Forsch., 97,* 373-81 (1953); *Food Sci. Abstr., 26,* No. 1755 (1954).

**A technic for stepwise degradation of proteins from the amino-end.**

FRAENKEL-CONRAT, H. *J. Am. Chem. Soc., 76,* 3606-7 (1954).

The principal feature is the use of small strips of filter paper as carriers for the protein throughout the procedure. The distribution of the protein over a big surface renders it accessible to the reagents and prevents pptn. by acid.

**Phosphorus linkages in α-casein.**

PERLMANN, G. E. *Nature, 174,* 273-4 (1954).

This is claimed to supply the first exptl. evidence of the existence of pyrophosphate bonds in a protein. It is also shown that α-casein, in addn. to phosphomonoesters, also contains some of its P as pyrophosphate and phosphodiesters.

**The association between proteins and lipids and the significance for biological permeability.**

BOOIJ, V. H. L. *Kolloid Z., 136,* 16-25 (1954).

As regards the structure of detergent/protein aggregates *2* possibilities arise: 1) the protein is the center of the particle and *2*) the matrix of the particle is a detergent-micelle. The aggregate seems to be built up of large detergent micelles coated with gelatin. Salt is needed to promote the formation of micelle precursor. Depending on the circumstances Coulomb-forces or ion/dipole interactions play the most important part in the binding between protein and detergent. Although the theoretical background of this assocn. is still poorly understood, it may lead already to some biol. expts. It is shown that combination of detergent and ions leads to some unexpected results, when the influence on fermentation by baker's yeast is measured.

**Inactivation of insulin by rat liver extracts.**

TOMIZAWA, H. H., NUTLEY, M. L., NARAHARA, H. T., AND WILLIAMS, R. H. *J. Am. Chem. Soc., 76,* 3357-8 (1954).

Evidence presented indicates insulin to be inactivated mainly by proteolysis.

### MICROBIOLOGY

**The preparation of cell-free enzymes from microorganisms.**

HUGO, W. B. *Bacteriol. Revs., 18,* 87-105 (1954).

Discussed are: (A) Technics for growing cells from enzyme studies. (B) Methods of prepg. cell-free enzymes from microorganisms; (1) disruption with abrasive particles; (2) crushing without the use of abrasives; (3) disintegration by agitation with small particles; (4) disruption of bacteria by the use of sound waves; (5) disintegration by alternate freezing and thawing; (6) disintegration by forcing through a small orifice; (7) disruption by release of gas pressure; (8) prepn. of enzymes by destruction of the cell wall; (9) combination of standard methods; and (10) extracellular enzymes. 126 references.

(Continued on page 20)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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## SELECTED ABSTRACTS

(Continued from page 18)

### NUTRITION

**Plasma protein. V. The effect of the protein content of the diet on turnover.**

STEINBOCK, H. L., AND TARVER, H. *J. Biol. Chem., 209, 127-32* (1954).

Percent protein in the diet greatly influences the half life and rate of replacement of plasma protein. [This might be utilized as a test for biol. value of protein. A very short time interval is needed for this type of study.]

**Effect upon growth of the D isomers in synthetic mixtures of the essential amino acids.**

PHILLIPS, W. A., AND BERG, C. P. *J. Nutrition, 53,* 481-98 (1954).

Rats fed suboptimal percentages of the 10 essential amino acids as the chief source of dietary N grew somewhat better when the poorly invertible group of essential amino acids (valine, leucine, isoleucine, lysine and threonine) was supplied in the DL form at twice the L level. Presumably the extraneous D-amino acids provide N for limited synthesis of the non-essential amino acids, though much less readily than do even smaller amts. of glycine and ammonium citrate.

**Nitrogen balance and hemoglobin of adult rats fed amino acid diets low in L- and D-histidine.**

NASSET, E. S., AND GATEWOOD, V. H. *J. Nutrition, 53,* 163-76 (1954).

The N balance of adult, male Wistar strain rats was adversely affected by severe reduction of histidine in the amino acid mixt. that supplied all of the dietary N. Reduction of histidine resulted in a reduction of hemoglobin of as much as 20%. It is suggested that histidine requirements are met normally by ingestion; temporary dietary shortages may be made good by the degradation of hemoglobin to supply relatively large quantities of histidine.

**Effect of the level of animal fat in the diet on the maintenance, reproduction and lactation performance of dogs.**

SIEDLER, A. J., AND SCHWEIGERT, B. S. *J. Nutrition, 53,* 187-94 (1954).

The maintenance, reproduction and lactation performances of Cocker Spaniel dogs fed since weaning a basal ration either with or without the addn. of 4 or 8% fat (antioxidant stabilized choice white grease) or 18% sucrose were observed. On the basis of all criteria used, the results obtained were excellent when 4% animal fat was added to the basal diet.

**Histological differentiation of fatty livers produced by threonine or choline deficiency.**

NINO-HERRERA, H., HARPER, A. E., AND ELVEHJEM, C. A. *J. Nutrition, 53,* 469-80 (1954).

The fatty infiltration and occasional necrosis observed in the livers of rats fed a 9% casein-sucrose diet contg. choline were not apparent when diets contg. addnl. protein, threonine, or threonine and glycine were fed. The livers of rats fed diets in which the sucrose was replaced by either glucose or dextrin also appeared structurally normal.

**Intestinal absorption of vitamin $B_{12}$ in man.**

GLASS, G. B. J., BOYD, L. J., AND STEPHANSON, L. *Science, 120,* 74-5 (1954).

The intestinal absorption of vitamin $B_{12}$ may be controlled by the existence of a partial mucosal block which shows much similarity to that regulating the absorption of Fe in intestine. For absorption of vitamin $B_{12}$ in addn. to gastric intrinsic factor it is suggested also an "intramural $B_{12}$ acceptor" may be required.

**The vitamin $B_6$ content of milk products.**

HASSINEN, J. B., DURBIN, G. T., AND BERNHART, F. W. *J. Nutrition, 53,* 249-57 (1954).

As estd. by the growth response of *S. carlsbergensis,* sterilized-liquid-milk products were found to contain from 33-64% and dried-milk products 69-89% of the vitamin $B_6$ activity of the fresh milk used in their formulation. The heating process commonly used in industry for sterilization of liquid-milk products causes a considerable decrease in vitamin $B_6$ content.

**Nutritive value of parboiled wheat used in the near east.**

SHAMMAS, E., AND ADOLPH, W. H. *J. Am. Dietet. Assoc., 30,* 982-3 (1954).

Wheat and parboiled wheat, when fed to rats, produced equally satisfactory growth over a period of 30 days. The nutritive value of the protein fraction, measured in terms of the protein efficienccy, remained unaltered when wheat was converted into parboiled wheat.

**Experimental rat caries. IV. Effect of a natural salt mixture on the caries-conduciveness of an otherwise purified diet.**

SOGNNAES, R. F., AND SHAW, J. H. *J. Nutrition, 53,* 195-206 (1954).

More carious lesions were observed in rats receiving a purified ration complete in known essentials than in those receiving the same ration with the ash of a natural diet as the source of minerals. It is suggested that the observed caries protection may have resulted from the presence of certain trace elements in the ash mixt. of the natural stock diet.

**Experimental rat caries. V. Effect of fluorine on the caries-conduciveness of a purified ration.**

SHAW, J. H., AND SOGNNAES, R. F. *J. Nutrition, 53,* 207-14 (1954).

Extensive carious destruction was produced in Norway rats of the Long-Evans strain which were raised on a generally adequate purified ration, in spite of the addn. of 6 or 25 p.p.m. of F, as NaF, to the ration during the period before eruption of the teeth. The data suggest that there are other minerals or ratios of minerals which are major factors in detg. the difference between sound and carious teeth.

**Growth, food utilization, and thyroid activity in the albino rat as a function of extra handling.**

RUEGAMER, W. R., AND BERNSTEIN, L. *Science, 120,* 184-5 (1954).

Animals in an extra-handled group showed a significantly greater wt. gain than rats in an unhandled group. There was no statistical significance between the amts. of food eaten by the 2 groups. Better utilization of food was also indicated by the handled animals. Further investigation showed that the thyroids of the unhandled animals were in a more active state.

**Partial starvation and alcohol metabolism. An example of adaptation to undernutrition.**

VITALE, J. J., NAY, J., AND GEGSTED, D. M. *J. Nutrition, 53,* 533-41 (1954).

The study appears to provide a clear-cut example of adaptation to undernutrition.

**The philosophy of food fortification.**

NELSON, E. M. *J. Am. Dietet. Assoc., 30,* 984-6 (1954).

A review of the statement of policy set forth by the Food and Nutrition Board in 1941.

### PHARMACOLOGY

**Chemical similarity and biological activity of the saponins isolated from alfalfa and soybeans.**

POTTER, G. C., AND KUMMEROW, F. A. *Science, 120,* 224-5 (1954).

Both the purified alfalfa and soybean saponins inhibited the growth of chicks while their genins did not. At least part of the growth-depressing effect of uncooked soybean meal may be due, therefore, to the soyasapogenols which on cooking hydrolyze to nontoxic genins.

### PHYSIOLOGY

**Multiple factors in thirst.**

ADOLPH, E. F., BARKER, J. P., AND HOY, P. A. *Am. J. Physiol., 178,* 538-62 (1954).

The authors believe that 2 kinds of stimuli are necessary to induce drinking: (1) depletion of body $H_2O$, or (2) excess in the body of a solute in a concn. hypertonic to blood plasma. Work done with rats and rabbits.

(Continued on page 22)

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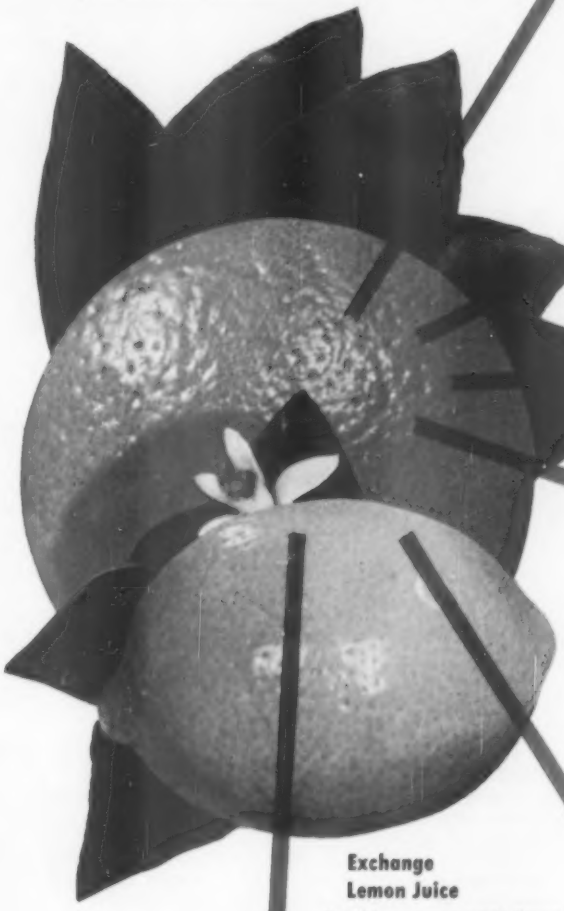

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## SELECTED ABSTRACTS

(Continued from page 20)

## ENGINEERING AND PLANT EQUIPMENT

**Processing variables in solvent extraction towers.**

VOGT, H. J., AND GEANKOPLIS, C. J. *Ind. Eng. Chem., 46,* 1763-8 (1954).

The effects of tower ht., end design, direction of extn. flow rate, concn. and solute on liquid-liquid extn. efficiency in towers are evaluated. The Blanding and Elgin design was investigated and compared with the more common type of spray towers. A tower design method using data from a single run is proposed.

**Fermentor for small-scale submerged fermentations.**

DWORSCHACK, R. G., LAGODA, A. A., AND JACKSON, R. W. *Appl. Microbiol., 2,* 190-7 (1954).

The description and operation of a 20 l. stainless steel fermentor similar in design to industrial units are given. Comparisons of data obtained from the 20 l. and a larger pilot plant fermentor are given in this report for the production of dextransucrase, Ca 2-keto gluconate, and riboflavin.

## FOOD AND FOOD TECHNOLOGY

### CANNED AND FROZEN FOODS

**Waxy rice flour improves frozen, canned foods.**

*Rice J., 57,* 20, October, 1954.

Flour made from waxy or glutinous rice has solved troublesome problems of texture in frozen and canned precooked foods. The waxy rice flours improve the stability of these prepd. foods.

### CEREALS AND GRAINS

**Dye-binding capacities of wheat flour protein fractions.**

UDY, D. C. *Cereal Chem., 31,* 389-95 (1954).

These fractions were essentially sol. proteins, gluten proteins, a combination of these 2, and proteins nondispersible in dil. AcOH. The highest binding capacities were obtained with the sol. protein fraction and the lowest with the most insol. fraction.

**Proteins, glutens, and lipids in wheat and flour.**

HESS, K. *Kolloid Z., 136,* 84-99 (1954) (in German).

A differential method, worked out for the sepn. of proteins, allows almost quant. yields of both protein complexes. The significance of the lipophosphate for the hydration and plasticizing processes of flour and dough was shown experimentally through the sepn. of the lipide phase of the flour into fat and lipophosphate.

**Differences in the distribution of components in albumin preparations from durum and common wheat flours.**

PENCE, J. W., WEINSTEIN, N. W., AND MECHAM, D. K. *Cereal Chem., 31,* 396-406 (1954).

Visual comparisons of paper electropherograms showed durum prepns. to contain large amts. of the α group of components and only small amts. of the β- and γ-albumins. In prepns. from club and common wheat flours the β- group was present in the greatest amts., the β-2 and β-3 components being characteristically prominent. These differences in component distribution appear to be independent of differences in growth location and crop year.

### FEEDINGSTUFFS

**Cottonseed meal in poultry feed. A distinctive yolk component in fresh eggs of hens fed gossypol.**

GRAU, C. R., ALLEN, E., NAGUMO, M., WORONICK, C. L., AND ZWEIGART, P. A. *J. Agr. Food Chem., 2,* 982-6 (1954).

Yolks of hens fed gossypol contain a yellow component not extractable by acetone, but sol. in 3:1 hexane-acetone. Although the amt. of this component, estd. by its absorbance at 400 mμ, was related directly to the level of gossypol fed, its absorption spectrum was different from that of gossypol.

### GELATIN

**Structure of collagen.**

RAMACHANDRAN, G. N., AND KARTHA, G. *Nature, 174,* 269-70 (1954).

The new proposed structure, consisting of 9 amino acid residues all having *trans* configuration, differs essentially from the 3 chain structure of Pauling and Corey. Further details are to be published in a future paper.

**The N-terminal amino acid residues of gelatin. I. Intact gelatins.**

COURTS, A. *Biochem. J., 58,* 70-4 (1954).

Glycine was found to be the predominant end group. Serine, threonine, alanine, aspartic acid and glutamic acid residues also occurred. The no.-av. mol. wt. of these samples calcd. assuming one N-terminal residue in each mol. Av. values of 60,000 were in agreement with those obtained by osmotic-pressure methods and support the view of a non-branching peptide chain.

### PECTIN

**Pectin. Evidence of molecular constitution from dry grinding experiments.**

LAMPITT, L. H., MONEY, R. W., AND JUDGE, B. E. *Chemistry & Industry, 113* (1954).

These results support the theory that the basic chain length of pectin is comparatively short and that these chains are combined by H bonding to give the larger mol. complexes indicated from viscosity measurements leaving the reducing end-group free to react.

### SEAFOOD

**The sea and world food supplies.**

FINN, D. B. *Nutrition Abstr. & Revs., 24,* 487-96 (1954).

The following are discussed: The state of world food supplies. Supplies of food from fisheries: consumption of fishery products per head. The prospect for increase in aquatic food: phytoplankton and seaweeds, zooplankton, marine fish, crustaceans and molluscs, freshwater fish: fish culture.

## PHYSICAL RESEARCH

**An experimental study of polydispersity by light scattering.**

BENOIT, H., HOLTZER, A. M., AND DOTY, P. *J. Phys. Chem., 58,* 635-40 (1954).

In the usual treatment of light scattering from solns. of randomly kinked chain mols., the initial slope of the reciprocal angular envelope at zero concn. is used to obtain the dimension of the $Z$-av. mol. wt. species, and the intercept at $\theta = 0$ is used to get the wt. av. mol. wt. The present paper describes in detail a method utilizing data which fall on the asymptote of this angular envelope, rather than on the initial part. It is shown that such data provide the no. av. mol. wt., and the no. av. dimensions.

## RADIOCHEMICAL TECHNOLOGY

**Effects of ionizing radiation on immunity.**

HALE, W. M., AND STONER, R. D. *Radiation Research, 1,* 459-69 (1954).

Ionizing radiation markedly reduces or abolishes active or passive immunity to bacterial infections and reduces resistance and active immunity to animal parasite infections. Ionizing radiation has little, if any, effect on acquired immunity to viral infection, and it does not significantly depress active or passive immunity to bacterial toxins. Antibody formation is greatly inhibited by ionizing radiation. There does not appear to be convincing evidence for stimulation of antibody production by small doses of radiation.

**The treatment of post-irradiation infection.**

HAMMOND, C. W. *Radiation Research, 1,* 448-58 (1954).

A considerable degree of success in the case of the mouse has been obtained in treating post-irradiation infection by means of antibiotics. Animals not too severely damaged were carried over the crucial period when their natural defense mechanisms were impaired. It might be well to warn against extrapolating directly to man the results of the exptl. work.

**The time-intensity relations of whole-body acute x-irradiation and protection by β-mercaptoethylamine.**

RUGH, R., AND CLUGSTON, H. *Radiation Research, 1,* 437-47 (1954).

(Continued on page 24)

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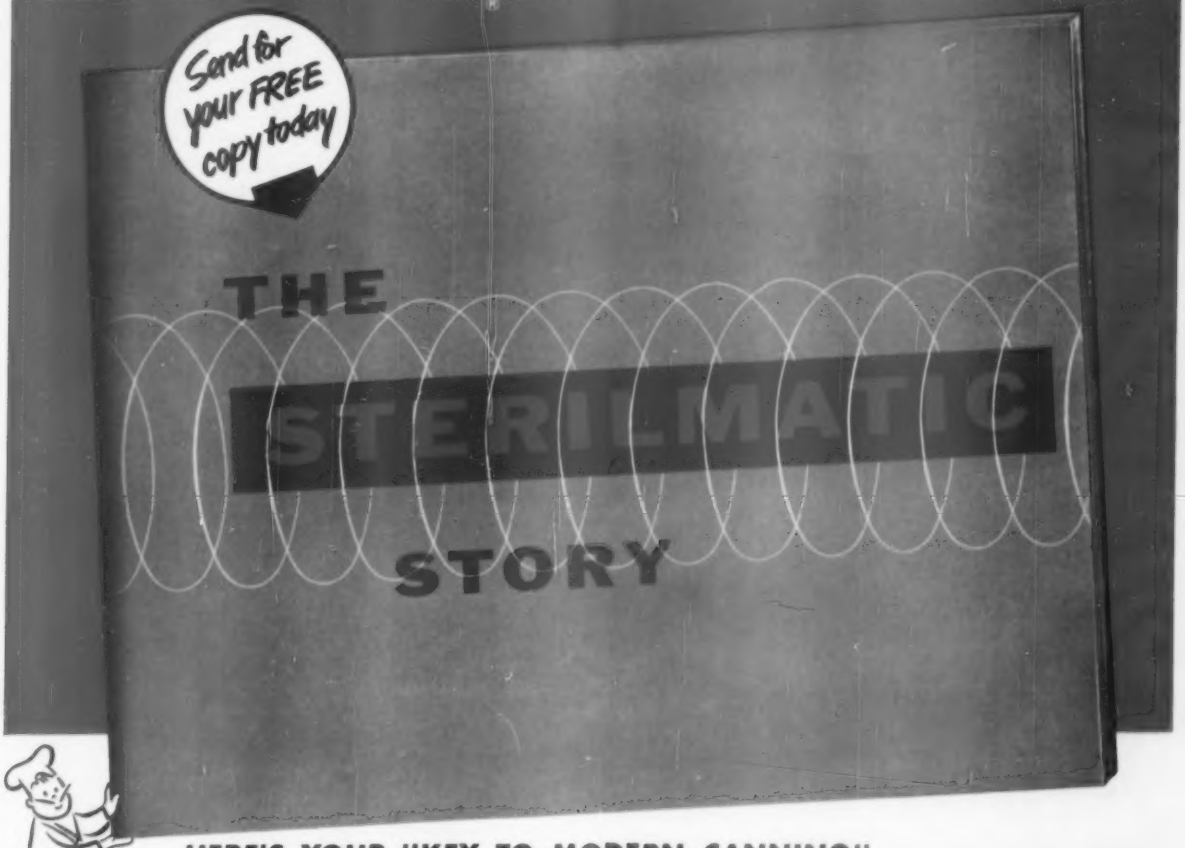

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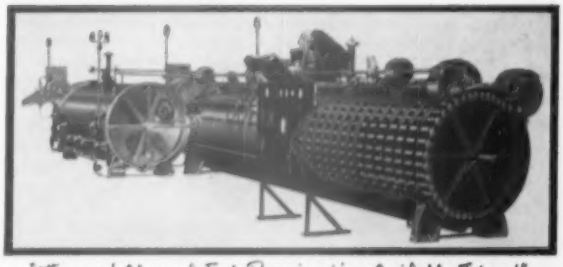

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## SELECTED ABSTRACTS

(Continued from page 22)

Male mice irradiated at different whole body x-irradiation rates died sooner at the slow rate of administration (total irradiation equal). There is no evidence of protection by β-mercaptoethylamine injected intraperitoneally into mice prior to x-irradiation to death. Under certain circumstances there is a prolonged survival. Injection of the drug after irradiation results in a more rapid death.

## WATER, SEWAGE AND SANITATION

**Streptococci as indices of pollution in well-waters.**

MORRIS, W., AND WEAVER, R. H. *Appl. Microbiol., 2,* 282-5 (1954).

The nos. of coliforms and streptococci in the well waters were found to be, on the av., identical. The coliforms and the streptococci were found to be of equal value as index organisms for detecting the presence, absence, or extent of pollution in freshly collected well-water samples. For the examn. of the stored samples, the test for streptococci appeared to be slightly superior, since the nos. of streptococci never increased in the sample, while the nos. of coliforms might either increase or decrease.

**Determination of bacterial numbers on tableware by means of direct plating.**

BARTON, R. R., GORFIEN, H., AND CARLO, R. M. *Appl. Microbiol., 2,* 264-7 (1954).

Procedures are described for direct plating procedures for *in situ* detection of bacteria on metal mess trays, soup bowls, cups and cutlery. Two hundred comparisons between the direct plating procedure and swab tests were made. In these comparisons, 3.87-29.3 times as many bacteria were detected by the direct plating procedure as by swab tests.

## MISCELLANEOUS INFORMATION

**A method for the in vivo evaluation of skin sanitizing soaps.**

QUINN, H., VOSS, J. G., AND WHITEHOUSE, H. S. *Appl. Microbiol., 2,* 202-4 (1954).

The split-use handwashing method has been found to provide a simple, rapid, and reliable procedure for enumeration of the bacterial flora of the hands after use of test soaps contg. antibacterial additives. It has been shown by use of this method, as well as by a more conventional procedure, that several types of compds. retain their skin disinfecting ability after incorporation in soap.

**How do you judge a whipping agent?**

HENIKA, R., REGER, J., AND TENGQUIST, H. *Mfg. Confectioner, 34,* 13-15, July, 1954.

Quick foam tests commonly are used to predict performance of whipping agents in aerated foods. However, some whipping agents which perform well in the foam test may not work well when actively used in certain aerated confections. This report illustrates this inconsistency as well as the opposite case, that a whipping agent may perform much better in actual use than would be predicted from a foam test.

## PATENTS

**Method of improving the whipping properties of gelatin and gelatin containing products and the resulting products.**

CONRAD, L. J., AND STILES, H. S. Assignors to Kind & Knox Gelatin Co. 2,692,201, October 19, 1954.

The method of treating gelatin to improve the whipping properties which comprises adding an effective amt. of an ester of an aliphatic carboxylic acid.

**Stabilization of organic compounds.**

CHENICEK, J. A., AND THOMPSON, R. B. Assignors to Universal Oil Products Co. 2,692,202, October 19, 1954.

An org. material normally subject to oxidative deterioration contg., as an inhibitor for the deterioration, a monoalkyl ether of a dihydroxy-hydronaphthalene in an amt. sufficient to retard the deterioration.

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(Continued on page 30 following technical papers)

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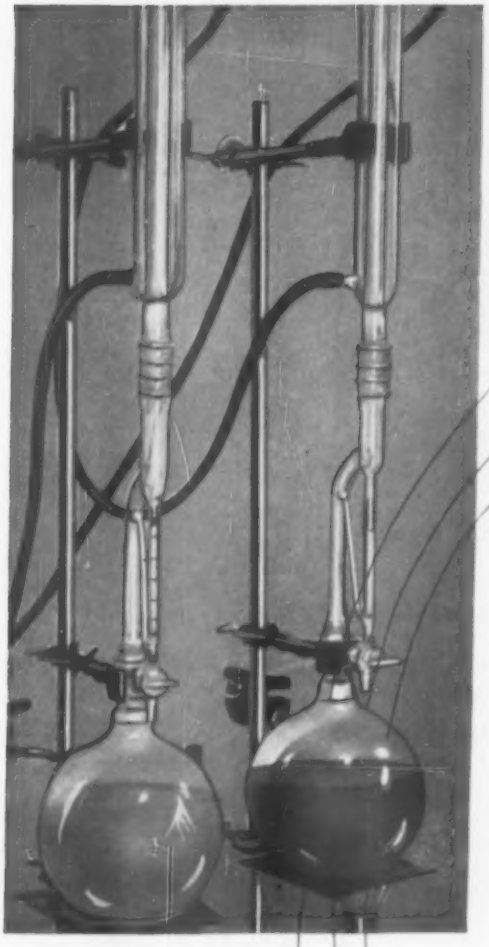

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# Dietetic Foods from the Viewpoint of the Dietitian[a]

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(Manuscript received July 14, 1954)

Dietetic foods are leaving the confines of the health food stores and entering the expanses of the supermarkets. Small wonder that manufacturers have developed a keen interest in dietetic foods with an estimated thirty million dieters in the United States. Thirty million potential customers mean big business. Twenty-five millions dieters are said to be reducing. Most of the remainder are struggling with ulcers, allergies, high blood pressure, cardiac difficulties, and diabetes.

The dietitian is concerned with dieters, primarily in the hospital but also in the home. The dietitian's chief aim is to provide every patient in the hospital with a nutritious, attractively served, appetizing diet that he will eat. The problem is that of a sick individual in unfamiliar and undesired surroundings whose illness and medications have frequently taken away all desire for food but whose very life may depend upon consuming the prescribed diet. What the patient eats when he goes home is also important. The beneficial results of the hospital stay may be undone in a few days by disregard of dietary instructions. Most homes do not have the facilities for the preparation of difficult diets; thus dieting may become a major problem.

The dietitian is also concerned, as a matter of course, with dietetic foods. In hospital food service fruits canned without added sugar and low sodium canned vegetables are used, as well as canned fruits with non-caloric sweeteners and meats canned with no added salt. The storeroom shelves may contain small stocks of the baby foods of commerce, such as custards and puddings and pureed or chopped vegetables and fruits. Fresh low sodium milk can be purchased in some areas and be made available to the patient. Various wheatless products such as rye wafers, rice biscuits, and arrowroot crackers are also procurable and served on occasion. But on the whole, most of the dietetic foods called for on the various diets are prepared in the hospital kitchen or diet kitchen or bakery. This has its disadvantages and dietitians have expressed a desire for the wider availability of commercially prepared dietetic foods. They would no doubt use or recommend to patients many more than they do now once they were assured that the foods met and conformed to standards.

## SOME SUGGESTIONS FOR THE TECHNOLOGISTS

The common diet modifications for which dietetic foods have been or could be used are chiefly these: low cellulose, allergy, low cholesterol, high protein, low carbohydrate, low caloric, and low sodium.

**Low cellulose diets.** Patients with peptic ulcer and other gastrointestinal disturbances are often on low cellulose diets for extended periods, and the diet can become tiresome and monotonous. Obtaining variety and preparing attractive meals within this limitation can become very much of a burden to the housewife responsible for their preparation; procuring an adequate diet of this kind when eating away from home is nearly impossible. Canned baby foods are helpful for those eating out, but many adults complain about the flavor of pureed vegetables of this type. An opportunity exists for the frozen food industry to prepare small packages of various pureed vegetables and fruits, giving the contents thereof and also the composition. Incidentally, baby foods would be more useful if the labels gave the percentage composition.

**Allergies.** Allergy is a common complaint but it is very much an individual problem. No general types of dietetic foods are useful for all persons with allergies. Important considerations in designing foods for the allergic dieters are accurate labelling and care in preparation to insure absence of even the smallest amounts of substances to be omitted. If intended to be wheat-free or egg-free or other substance-free they must be entirely devoid of these substances and must so state on the label. Such items as wheat-free, egg-free and milk-free breads, cakes, and cookies canned in a manner similar to the canned brown breads and date breads would provide variety in allergies requiring exclusion of these items.

**Cholesterol.** Restriction of cholesterol is being emphasized in the treatment of some conditions. A diet in which low cholesterol is combined with high protein is not uncommon. This is a difficult order to fill since foods of animal origin are among the best sources of protein as well as of cholesterol. The preparation of appetizing proteins of vegetable origin would aid in the filling of such dietary prescriptions. A number of companies including a large meat packing organization in Chicago are manufacturing purely vegetable steaks made largely of wheat gluten. If present in sufficient quantity, the yeast nutrients included among the ingredients doubtless improve the quality of protein in the gluten product. A soybean milk with an appetizing flavor and cost in line with that of fresh cow's milk would ease the lot of some low cholesterol as well as allergy dieters.

**High protein diets.** A reasonably priced product high in protein and of good biological value—one that readily dissolves in clear liquid and has no disagreeable odor or taste—would simplify the preparation of high protein diets. This is far from easy to accomplish as most protein supplements have an objectionable odor and taste or are difficult to dissolve. Frequently, patients requiring high protein diets have small appetites or digestive difficulties which make the ingestion of the high protein diet difficult or nearly impossible. The inclusion of protein in soups and beverages and other foods would markedly simplify the problem. If the product could also be made low in cholesterol, it would be advantageous in the planning of low cholesterol diets.

**Low caloric diets.** Probably more efforts are being expended by manufacturers in the area of low-caloric and low-carbohydrate foods than in any other. There is a demand for these items since in addition to the estimated 25 million reducers there are countless others, particularly women, who will choose low caloric items as a matter of principle—or because it is the fad. Low caloric mixes for hot breads, cakes, cookies, and pie crusts may present technical difficulties in manufacturing, but they are items to consider. As food for thought—what about frozen fruits with non-caloric sweeteners?

**Low sodium.** The demand for low-sodium diets appears to be increasing. "The potential market for low-sodium foods

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 28, 1954.

[b] Director of Dietetics.

may be conservatively estimated to be equal in magnitude to the market for canned, strained, and chopped foods for infants and small children," stated Dr. Franklin Bing in 1951. There is probably no more difficult dietetic problem than that of the low-sodium diet. Until sodium is restricted, we usually do not realize the important place that salt plays in the preparation and palatability of our foods. The low sodium diet is unappetizing for most individuals even when mildly restricted. Some dieters find the diet repulsive to the extent that they completely lose their appetites and develop various dietary deficiencies. When a patient, very ill and already devoid of appetite, is placed on a diet of low sodium content the problem may become acute. Certainly anyone who can do anything to add palatability and variety to this diet will be rewarded.

Bakeries in many areas are supplying "salt-free" breads and other items with low sodium content. There are canned vegetables and meats with no added salt on the market. Low sodium fresh milk and cottage cheese is being made available in some localities. Many of these products are not labelled to show the percentage composition and amount of sodium, however. This knowledge is essential to the dietitian. If foods are to be of any value in the low sodium diet, this information must be accurately stated. Frozen vegetables would add a pleasant variety to the low sodium diet if the technologists could give assurance that no sodium contamination has resulted from the salt blanching operation.

It takes time and effort and considerable imagination to prepare an appetizing, attractive diet without salt. Several cook books are on the market with suggestions regarding the use of herbs and other seasonings as acceptable substitutes for salt—that is, the salt taste. But most homemakers and many hospitals find it an almost impossible task to prepare attractive and appetizing low sodium diets. The low sodium dieter finds his diet extremely monotonous unless he can become accustomed to seasoning his foods with salt substitutes, herbs, spices, and flavorings. When he does become accustomed to such replacements for salt, he would welcome an expansion of the list of main dishes, canned or frozen or dried and packaged, of low sodium content nicely seasoned with herbs and/or tomato and acceptable salt substitutes. Low sodium cake and other mixes would also be of definite interest to him. Prepared foods, well standardized, chemically analyzed, and accurately labelled would meet a genuine need. Quite a list of foods with controlled sodium contents is reported to be available, but the question is—where? To be of benefit to the dieter he must know where and how to get them.

## UNFULFILLED COMMON NEEDS

Dietitians have made various comments with regard to unfulfilled needs for dietetic foods. One dietitian reported that patients in her hospital complained about an unpleasant taste in the fruits sweetened with non-caloric sweetener. Another wished that fruits of choice quality were canned with light or medium syrup, since patients so often complain that canned fruits are too sweet. One dietitian suggested that frozen dietetic foods —low caloric, low sodium, etc.—be sold in the markets and placed in clearly designated special cabinets used only for dietetic foods. Several wished that salt-free margarine were available. It is said to be manufactured, but these dietitians do not know where it is available. Canned low sodium milk was another suggestion for the technologists to think about. Others would like salt-free high protein foods that taste good, salt-free peanut butter, fatless peanut butter. Convenient, completely cooked or baked, dietetic, frozen foods are yet another unfulfilled need.

**Ten general suggestions for dietetic foods.** 1. *Accurate chemical analysis* should be done on all dietetic foods. 2. *Informative labelling* is essential. The exact chemical composition should be stated on cans and packages. It would be helpful if labels listed ingredients; calories; percent of fat, carbohydrate, and protein; milligrams of sodium per 100 grams of contents; any alteration in the nutrients commonly present in the product. Labelling must be accurate and specific. Without analysis and accurate labelling dietetic products are unusable for dietitians and dangerous for patients. It has been suggested that a code of ethics in analysis and labelling be devised to guide manufacturers of dietetic foods—a code similar to that of the drug manufacturers. Dietetic foods shipped interstate come under the jurisdiction of the Federal Food and Drug Administration. 3. *Terminology* should be standardized and specific. 4. *Nutritional value* is important and must not be overlooked. Losses should be kept at a minimum during manufacture, distribution, and storage. A check should be made from time to time to determine the nutritive value at time of consumption. There may be differences between the values when manufactured and when consumed. 5. The *utility* of dietetic foods is another factor. Ease of preparation is very important. Examples of easy-to-prepare items are convenient completely cooked frozen foods, pre-cooked dietetic frozen meals and easy-to-prepare mixes. 6. *Ease of procurement* is equally important. Unless a product is made readily available its sale will be limited. 7. This brings up the factor of *advertising*. More extensive advertising needs to be done, particularly to make some products better known. 8. There is need for *a catalog* or *bulletin* to be distributed to the dietetic and medical profession listing the various dietetic foods, giving information regarding them, the name of the manufacture and his address, the source of distribution, and where the products may be obtained in given areas. 9. *Standardized recipes* for both home and institutional use are important. These should be simple, easy to prepare, and avoid ingredients difficult to obtain. Suggestions as to where to obtain ingredients not commonly used should be included. 10. Last but not least, there needs to be *less differential in price* between dietetic foods and other foods. Prices have frequently been considerably more than for similar foods not dietetic.

## SUMMARY

There is need for a variety of palatable substitutes for basic foods, modified for specific purposes. To be acceptable dietetic foods must closely approach other foods in flavor and color as well as in texture and nutritive value. They must be attractive in appearance and products that the average person would enjoy eating. They should be easy to prepare, well advertised, and easily available. For dietetic use in hospitals or in the home, they must be chemically analyzed and accurately and specifically labeled. The manufacture of dietetic foods presents many challenges and numerous opportunities for the technologist.

# The Functional Properties of the Egg White Proteins

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(Manuscript received July 17, 1954)

**Egg white has been chemically fractionated into its principal protein constituents and the function of each in the preparation of angel cakes has been demonstrated. The important constituents were found to be the globulins, ovomucin, and ovalbumin.**

Since utilization of egg white in food preparations depends primarily on its properties of foam formation and heat coagulation, the effects of various treatments and substances on these properties have been extensively studied *(3)*. It has long been held that the protein ovomucin is responsible for the gel-like character of thick egg white *(1, 14)*, and information available indicates that ovomucin performs a function in stabilization of egg white foams. High shear homogenization, which damages the whipping property of egg white, does alter the character of the ovomucin as isolated by a dilution technique *(7, 10)*. Previous studies, however, have not generally considered the contributions of the individual components of egg white to its functional properties.

To provide means of improving quality in both shell eggs and egg-white products (frozen and dried egg white), the function and behavior of specific components must be determined. In the present study we have separated egg white into specific protein fractions in order to appraise the contribution of these fractions to the functional properties of egg white. In addition, studies are reported on the properties of repeatedly whipped whites and on the effect of reductive and natural thinning on functional properties of egg white. The performance in the preparation of angel food cakes was used as the method for appraising functional performance.

## METHODS

The angel-cake test used in this study has been described previously *(10)*. In order to ascertain the maximum cake volume attainable by each lot of egg white, cakes were baked from samples of the white whipped for different periods of time and thus to different specific gravities of meringue. The importance of utilizing this technique to describe the cake-making properties of a lot of egg white is demonstrated in Figure 1. Two lots of fresh, normal egg white and 2 samples from which different fractions of the white have been removed are shown to have grossly different whipping curves. Meringue specific gravities of some of the cakes are noted on the curves for illustrative purposes. Comparison of meringue specific gravities and of whipping time required for optimum cake volume shows that optimum volume cannot be obtained for all samples by whipping to a single specific gravity or for a constant time. Egg whites that have been altered by homogenization, reduction, removal of components, and possibly by aging yield cakes of optimum volume at different stages of foam stiffness. Some samples have been found that make the best cake at a very stiff and dry meringue stage which, for normal egg white, would be grossly overbeaten. Thus, although the procedure of evaluating egg whites by determining the optimum cake volume obtainable is somewhat laborious, it does yield an accurate measure of the quality of egg whites subjected to a wide variety of treatments. In these experiments optimum cake volume obtainable with a given sample is the only value reported except in cases in which volumes obtainable at various whipping times are of interest.

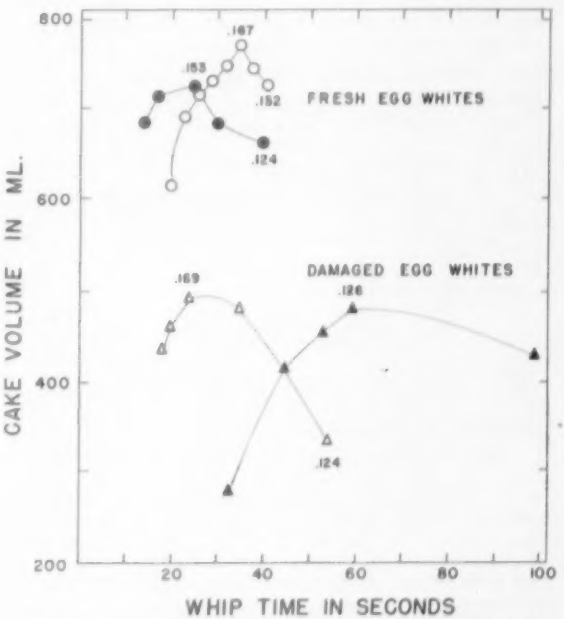


**Figure 1. The relationship of angel cake volume to whipping time. The fresh egg whites were from different lots. For the damaged egg whites, △ represents a sample from which the globulins were removed; ▲ represents a sample from which both the globulins and ovomucin were removed. The numbers on the curves are the meringue specific gravities at the whip times specified.**

**Chemical treatment.** Chemically thinned and naturally thinned egg whites were prepared by the techniques previously reported *(6, 12)*.

The proteins of egg white were fractionated according to the scheme presented in Figure 2, which represents a typical fractionation. Although lysozyme is a globulin and has been treated as such in this study it had to be handled separately in the fractionation because it readily forms a complex with ovomucin (see below). Thus, any of the many dilution techniques for isolating ovomucin in the presence of lysozyme yield a material of variable solubility and a high lysozyme content. The procedure employed to obtain purified ovomucin is described in greater detail elsewhere *(11)*. Dialysis against egg white was performed to insure a salt concentration in equivalence with normal egg white; experiments indicated that the substitution of 1% NaCl for the dialysis step was satisfactory for preparing angel cakes. Either dialysis or salt addition was necessary to insure proper dispersal of the globulin fractions.

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The various fractions were stored either in concentrated solution in the presence of 0.05 to 0.10% merthiolate at 4° C. (39.2° F), or were dried by lyophilization. Satisfactory storage of ovomucin samples was not achieved; samples could not be frozen or dried because an irreversible change occurred which impaired the protein solubility. Solutions containing 1 to 2% protein (higher concentrations were relatively difficult to prepare because of the high viscosity of the solutions) could be stored 4 to 5 weeks in the refrigerator in the presence of merthiolate but usually at this time mold or bacterial growth would begin.

EGG WHITE (3000 ml, 4.0 mg. lysozyme / ml)
pH 9.5, 5% NaCl, 4° C, 5-7 days
Crude lysozyme crystals
Dissolve pH 6, Centrifuge
Lysozyme - free filtrate
(0.8 mg. lysozyme / ml)
Dialyze vs. 18 liters $H_2O$, adjust — pH 4.5
Insoluble (discard)
0.4% total N
Lysozyme sol'n (300 ml)
3.9% total N
(globulin)
Crude ovomucin ppt.
Wash 1% NaCl and $H_2O$
Dissolve pH 9-10
ovomucin sol'n (600 ml)
4.1% total N
Lysozyme - ovomucin free filtrate
Dialyze and conc. by lyophilization
Lysozyme - ovomucin free conc. (2000 ml)
88.4% total N
500 ml
1500 ml
adjust — pH 9.5,
add 1 vol. sat'd $Na_2SO_4$
filter with celite
Dialyze vs. 1700 ml. egg white
Lysozyme - ovomucin free fraction
equiv. to 2250 ml. orig.
Crude globulin ppt.
Extract from celite,
dialyze and conc.
by lyophilization
Globulin fraction (89 ml)
6.2% total N
Globulin - ovomucin free filtrate
Dialyze, conc. by lyophilization,
dialyze vs. 2.5 vol. egg white
Globulin - ovomucin free fraction (410 ml)
78.9% total N
equiv. to 750 ml. orig.
a Calculated to original volume of egg white

**Figure 2. The chemical fractionation of egg white.**

The fractionation procedure employed posed some difficult problems in manipulation, since the cake tests required fairly large quantities of material. Thus, large and unwieldy volumes of solution had to be handled. The most cumbersome step was that of dialysis to remove the fractionating salts. Also, bacterial growth was a problem even though all dialyses were done at 4° C. (39.2° F.).

## RESULTS AND DISCUSSION

**Properties of repeatedly whipped white.** It is well known that the liquid that drains from a relatively stiff egg white foam differs in whipping properties from the original egg white. Forsythe and Bergquist *(7)* reported a lower ovomucin content in the drained material than was present in the original white. They found approximately the same ovomucin content in material drained from foams whipped 30 seconds and foams whipped 90 seconds. However, a decreased beating rate found on whipping the drip from the 90-second whip was not found on whipping the drip from the 30-second whip, suggesting changes other than in ovomucin. Bergquist and Stewart *(4)* found that the beating rate of the material drained from egg white foams was not greatly affected unless the foams had been whipped to high specific volume (low density).

It was felt that a more thorough analysis of the liquid that drained from foam might indicate what components of egg white are damaged or are important in foaming or what chemical changes might be associated with foaming. In the present study a sample of white was whipped to the stage at which it was most stable and the drip from the foam was re-whipped. This was repeated twice on the drips. Table 1 presents the data from this experiment.

**TABLE 1**
**The properties of rewhipped egg white**

| Material whipped | Egg white | 1st drip[1][2] | 2nd drip [1] | 3rd drip [1] |
|---|---|---|---|---|
| Total solids | 12.2% | 12.2% | 12.3% | 12.5% |
| Liquid specific gravity | 1.0234 | 1.0230 | 1.0254 | 1.0240 |
| $sp^0$ | 4.79 | 3.13 | 2.70 | 2.48 |
| N (dry wt.) | 13.8% | 14.0% | 13.9% | 13.3% |
| Ovomucin N[3] | 2.51% | 0.91% | 0.74% | 1.09% |
| Whip time required to produce most stable foam | 50 sec. | 70 sec. | 120 sec. | 150 sec. |
| Stability (drip volume for most stable foam)[4] | 2.2 ml. | 6.6 ml. | 16 ml. | 22 ml. |
| Foam specific gravity | 0.101 | 0.103 | 0.104 | 0.099 |
| Insoluble solids in foam [5] | 6.1% | 2.4% | 1.4% (max.) | < 0.5% |
| "Native"-SH (as cysteine)[6] | 0.45% | 0.47% | 0.46% | 0.45% |

[1] Drips were collected from the most stable foam of the previous sample. Multiple 50-ml. aliquots were foamed, the foams were pooled and allowed to drip overnight in a cold room. The essentially unchanged solids content is presumably due to water evaporation during dripping.

[2] Relative viscosity was measured by a capillary pipet at 30° C. after blending as previously described *(10)*.

[3] Ovomucin was separated by Balls and Hoover technique *(2)* and N was determined on dried samples.

[4] Fifty ml. of sample was whipped for the time required for production of the most stable foam in a modified bowl on a Hamilton-Beach mixer as previously described *(10)*. The figures represent the drip that accumulated in the first 30 minutes.

[5] A weighed sample of foam was centrifuged; the solids were washed twice with 1% NaCl and twice with $H_2O$, then dried in a vacuum oven.

[6] "Native"-SH was determined by a p-chloromercuribenzoate titration *(13)*.

It is apparent that most of the decrease in viscosity and ovomucin nitrogen occurs in the first whip, but that each additional whip causes a definite decrease in stability and increase in whip time required for the most stable foam. The viscosity of each drip is lower than that of the liquid sample from which it was prepared. Each drip had a much lower foam stability than that from which it was made even though all the samples whipped to the same specific gravity. There was also a regular decrease in the amount of material insolubilized in the foam. The essentially unchanged solids content was presumably due to water evaporation from the surface of the foam during dripping. It is interesting to note that the isolation of ovomucin according to Balls and Hoover *(2)* yields an appreciable amount of material from all samples. Thus it would appear that this method as used removes material other than ovomucin. Of even more importance are the constant cysteine values which indicate that ovalbumin goes through the repeated whippings unaltered. It has previously been shown *(2)* that all the sulfhydryl groups of egg white are in ovalbumin which contains 1.07% cysteine and that the reactive SH groups of native egg white correspond to 0.45% cysteine. The SH groups in denatured egg white correspond to 0.62% cysteine. Thus, it *appears* that ovalbumin is not selectively removed from solution during the foaming process, nor is the part that appears in the drip denatured, since the SH content of the drip is the same as that of the fresh egg white.

**Effect of reductive and natural thinning on functional properties of egg white.** The amount of thick white in egg white can be greatly lowered by treatment with reducing chemicals *(12)* or by storage at relatively

elevated temperature [30° C. to 40° C. *(6)*]. The viscosity of blended egg white is also lowered by such treatments *(5, 12)*. In order to determine the effect of these processes on the angel-cake-making properties of egg white, samples were treated with several levels of thioglycol one day prior to cake baking and other samples were aseptically separated and stored at 37° C. (98.6° F.) for 37 days prior to cake baking (Table 2).

**TABLE 2**

**Effect of chemical reduction and natural aging on functional properties of egg white**

| Treatment | pr | Thick white [1] | Whip time | Cake volume |
|---|---|---|---|---|
| | | % | *sec.* | *ml.* |
| Blended egg white control | 4.73 | 65 | 24 | 745 |
| 50 p.p.m. thioglycol | 2.90 | 34 | 47 | 755 |
| 300 p.p.m. thioglycol | 2.65 | 5 | 70 | 755 |
| 1000 p.p.m. thioglycol | 2.42 | 1 | 70 | 705 |
| Shell egg control | | 66 | 19 | 749 |
| Shell eggs stored 37 days at 37° C.[2] | [3] | 46 | 16 | 735 |

[1] For tests on effect of chemical reduction the cakes were made from blended egg white. A separate experiment was set up to determine the percent thick white.

[2] Bacteriological tests at the end of storage period demonstrated sterility of the samples.

[3] When blended egg white is similarly stored, a large decrease in viscosity occurs *(6)*.

It is apparent that reduction increases the whip time appreciably although it has no effect on the cake volume except at the highest level. Very high levels of thioglycol do cause some decrease in cake volume. Naturally thinned egg whites did not change in whipping time or in cake volume while whites thinned by homogenization *(10)* gave greatly increased whip times and lower cake volumes. Therefore, the two artificial methods of thinning egg white give no clue as to the mechanism of natural thinning.

**Effect of crude ovomucin on viscosity and foam stability.** When egg white is adjusted to pH 5, a large, gelatinous precipitate forms. The precipitate contains approximately 7 to 8% of the egg white nitrogen and all the ovomucin. It is presumably about 65% globulin. Since the material separated by this procedure is incompletely soluble, it is probable that a portion of the ovomucin exists as a complex with lysozyme *(5, 8)*. It can be partially redispersed at about pH 10 to form a viscous opaque slurry; however, centrifugation causes the swollen material to settle. A sample of egg white adjusted to pH 5 was tested for foam stability after removal of the gelatinous precipitate and after its addition again (Table 3). It is apparent that the viscosity of egg white and the stability of the foam (indicated by the drip) is dependent upon this fraction.

**Functional properties of the significant protein fractions.** Whipping times and cake volumes are given in Table 4 for several egg white fractions. Removal of the globulins and ovomucin caused a large increase in whip time and decrease in cake volume. In this particular experiment the replacement of these fractions to the globulin- and ovomucin-free material caused an appreciable recovery in whip time but did not result in a cake of good volume and texture. Indications were that the damage was in the globulin- and ovomucin-free white, possibly due to incomplete removal of the salt during dialysis. The globulins and ovomucin were obviously

**TABLE 3**

**Effect of crude ovomucin on egg white viscosity and foam stability**

| Sample [1] | pr [2] | Drip [3] |
|---|---|---|
| A. Egg white + 28% $H_2O$ | 3.34 | 5.8 |
| B. Egg white minus ovomucin plus water to 128% of original volume | 1.66 | 31.6 |
| C. Sample B with ovomucin replaced | 3.38 | 3.4 |
| D. Untreated egg white | 4.83 | 1.0 |
| E. Sample D + reconstituted ovomucin equivalent to amount replaced in sample C | [4] | 0.1 |

[1] The reconstituted ovomucin was made up to 28% of the volume from which it was isolated. Hence, samples A, B, C, and E were all made to a volume 128% of sample D. All samples were adjusted to pH 9 before measurement.

[2] See footnote [2], Table 1.

[3] See footnote [1], Table 1.

[4] By inspection, this sample had by far the greatest viscosity, but flecks of insoluble matter were present and a reliable viscosity value was therefore not obtained.

unchanged because substitution of ovalbumin for the globulin- and ovomucin-free fraction yielded a normal cake, although the whip time was longer than that of the control. The importance of the globulins and ovomucin in determining the properties of egg white foams is also evident from the fact that alone they will make an excellent meringue and angel cake batter. Of course,

**TABLE 4**

**Effect of several of the protein components on functional properties of egg white**

| Sample | Whip time | Cake volume |
|---|---|---|
| | *sec.* | *ml.* |
| A. Egg white | 27 | 735 |
| B. Egg white minus globulins and ovomucin | 125 | 331 |
| C. Sample B with globulins and ovomucin replaced [1] | 48 | 417 [2] |
| D. Globulins, ovomucin, and ovalbumin [3] | 45 | 730 |
| E. Ovalbumin, 17.8 mg. N/ml. | 60 | 688 |
| F. Ovalbumin, 17.8 mg. N/ml. + 2% NaCl | 65 | 638 |

[1] Globulins plus ovomucin at the concentration of their occurrence in egg white (2.7 mg. N/ml. total) make an excellent meringue and batter. Cake expands normally on baking but collapses.

[2] Cake volume did not return to normal, probably because of salt relationships in fractions. Therefore protein fractions were dialyzed against fresh egg white for next experiment on this subject (see Table 5).

[3] Sufficient 4 x crystallized ovalbumin added to make total N of sample 17.8 mg./ml. which was the value of the original egg white.

the batter on baking rises normally but then collapses. The collapse is probably due to lack of heat denaturable protein and the expanded globulin and ovomucin foam is not strong enough to support the other ingredients.

It was surprising to find that ovalbumin alone would make a cake; however, it must be emphasized that a cake made with ovalbumin alone lacks the unique qualities of an angel cake made from the complete white. It takes a long whipping time to form sufficient foam, the fine bubbles characteristic of the globulins are missing and a coarse-textured cake results. The presence of 2% salt decreased the volume of cakes made with ovalbumin alone.

Further fractionations and reconstitutions elucidate the functions of these proteins more clearly (Table 5). Removal of the globulins and ovomucin again caused increased whip time and decreased cake volume. Replacement of the globulins alone caused recovery of cake volume but only partial recovery of the whip time. Replacement of ovomucin alone greatly decreased the required whip time but had no effect on cake volume, and increasing the whip time further decreased the cake volume. However, when both globulins and ovomucin

**TABLE 5**
**Effect of globulins and ovomucin on functional properties of egg white**

| Sample | Whip time | Cake volume |
|---|---|---|
| | *sec.* | *ml.* |
| A. Egg white | 27 | 704 |
| B. Egg white minus globulins and ovomucin | 300 | 552[1] |
| C. Sample B with globulins replaced | 75 | 680 |
| D. Sample B with ovomucin replaced | { 49<br>{ 65 | { 531<br>{ 507 |
| E. Sample B with globulins and ovomucin replaced | 35 | 660[1] |

[1] Globulin-ovomucin-free filtrate in this experiment was dialyzed against egg white. This probably accounts for the fact that cake volumes were larger than those reported in Table 4.

were replaced, nearly complete recovery of whip time was obtained and the sample yielded a cake with large volume and good texture.

An additional experiment in which extra ovomucin and globulins were added to normal egg white yielded results consistent with those above (Table 6). Extra ovomucin greatly decreased the cake volume obtainable even at a shorter whip time than the original; however, extra globulins not only greatly decreased the whip

**TABLE 6**
**Effect of extra globulins or ovomucin on functional properties of normal egg white**

| Sample [1] | Whip time | Cake volume |
|---|---|---|
| | *sec.* | *ml.* |
| Egg white | 50 | 677 |
| Egg white concentrated 20% | 47 | 745 |
| Egg white + extra ovomucin [2] | { 42<br>{ 47 | { 637<br>{ 451 |
| Egg white + extra globulins [2] | 28 | 751 |

[1] Egg white was concentrated by lyophilization to 60% of its original volume and diluted as required.

[2] To 1 volume of egg white concentrate was added the ovomucin or globulins, as the case may be, isolated from an equal volume of egg white and made up to the original volume.

time required, but also increased cake volume obtainable. That this was not a solids effect alone is demonstrated by the cake prepared with 120% of the solids of egg white. Interpretations of this experiment could be as follows: This sample of normal egg white requires about 50 seconds' whipping to foam the globulins sufficiently; however, when extra ovomucin is added, too much protein is insolubilized in the bubble surface at 47 seconds and the cake is small because of decreased bubble elasticity. Shortening the whip time to 42 seconds prevents insolubilization of too much ovomucin but the cake is still smaller than the control because the globulins are incompletely whipped. However, when extra globulins are added, a larger-volume cake can be made at an appreciably shortened whip time. Thus, the total amount of globulin fraction present is then enough to obtain a large-volume foam at very short whip time and the ovomucin content of normal egg white is sufficient to stabilize this foam.

The function of the individual proteins might be postulated as follows. The globulins are extremely good foamers; they are of particular importance in forming a meringue and batter with a large volume, small bubbles and very smooth texture; consequently, they are important for a good-textured cake. The ovomucin is not a foamer but has the property of stabilizing the egg white foams at short whipping time, presumably because of its very rapid insolubilization at the surface of the bubbles. Overwhipping damage in angel cake preparation may thus be caused by insolubilizing too much ovomucin in the bubble surface, thus decreasing the bubble elasticity. The results obtained with addition of the globulins and ovomucin to ovalbumin support the hypothesis that all the other proteins of egg white merely furnish heat-denaturable bulk which on b-king insolublize to form the supporting matrix of the cake and do not impart any unique properties. The role of the other proteins might be more clearly elucidated by additional fractionation studies.

The evidence for the function of the individual proteins appears more impressive when an egg white naturally deficient in an important component can be made normal by the addition of that component from another source. It is well known that duck egg whites will not whip satisfactorily or make a satisfactory angel cake. We have studied the protein composition of the whites of various avian species *(14)*, and the most important difference found was the low lysozyme content in duck egg whites previously reported by Smolelis and Hartsell *(15)*. This suggested that the poor performance of duck egg white might be caused by an insufficient amount of globulins. In Table 7 are the

**TABLE 7**
**Effect of added globulins (from chicken white) on functional properties of Peking duck egg white**

| Sample [1] | Whip time | Cake volume | Cake texture |
|---|---|---|---|
| | *sec.* | *ml.* | |
| A. Chicken | 39 | 722 | Normal |
| B. Duck | { 39<br>{ 51 | 577<br>550 | Coarse |
| C. Duck + .46 g. lysozyme and 1 g. other globulins per 200 ml. | { 35<br>{ 39<br>{ 51 | 692<br>683<br>694 | Much less coarse than cakes made from duck whites.<br>Only slightly more coarse than cakes made from chicken whites. |

[1] Chicken white had 3.85 mg. lysozyme/ml. and duck white 1.57 mg. lysozyme/ml. For sample C, lysozyme was added to sample B to make the level equal to that in chicken white, and other globulins were added in approximately the same proportion.

results on angel cake performance of adding to duck egg whites globulins prepared from chicken egg white. While whipping time effects are small, the added globulins result in an improved egg white that makes an essentially normal angel cake. Although only lysozyme was demonstrated to be low in duck egg white, the other globulins were added in amounts similar to their occurrence in chicken egg white. The relative importance of the different globulins was not determined.

## SUMMARY AND CONCLUSIONS

Chemical fractionation of egg white into its principal protein constituents has shown the contribution of each to the performance of egg white in the preparation of angel cakes. The constituents found to be important are the globulins (including lysozyme), the ovomucin, and the ovalbumin. The globulin fraction is in large part responsible for good foaming, while ovomucin appears to stabilize the foam. The structure of the baked cake is dependent upon the presence of sufficient heat-denaturable protein, and this function is served pri-

marily by the ovalbumin. These findings led to the hypothesis that duck egg whites make poor angel cakes because they are lower in globulins than hen egg whites. Addition of globulins to duck egg white did result in an improved angel cake, compared with cake made with plain duck egg white.

**Acknowledgments**

The authors gratefully acknowledge the performance of certain analyses by E. D. Ducay, the cooperation of the Poultry Producers of Central California in obtaining eggs, and advice and criticisms of G. Alderton, J. G. Davis, and Hans Lineweaver.

LITERATURE CITED

1. Almquist, H. J., and Lorenz, F. W. Liquefaction of egg whites. *U. S. Egg and Poultry Mag.*, **38** (4), 20 (1932).
2. Balls, A. K., and Hoover, S. R. Behavior of ovomucin in the liquefaction of egg white. *Ind. Eng. Chem.*, **32**, 594 (1940).
3. Barmore, M. The influence of chemical and physical factors on egg white foams. Colo. Expt. Sta. *Tech. Bull.*, **9** (1934).
4. Bergquist, D. H., and Stewart, G. F. Surface formation and shear as factors affecting the beating power of egg white. *Food Technol.*, **6**, 262 (1952).
5. Feeney, R. E., Ducay, E. D., Silva, R. B., and MacDonnell, L. R. Chemistry of shell egg deterioration: The egg white proteins. *Poultry Sci.*, **31**, 639 (1952).
6. Feeney, R. E., Silva, R. B., and MacDonnell, L. R. Chemistry of shell egg deterioration: The deterioration of separated components. *Poultry Sci.*, **30**, 645 (1951).
7. Forsythe, R. H., and Bergquist, D. H. The effect of physical treatments on some properties of egg white. *Poultry Sci.*, **30**, 302 (1951).
8. Hawthorne, J. R. The action of egg white lysozyme on ovomucoid and ovomucin. *Biochim. et Biophys. Acta*, **6**, 28 (1950).
9. MacDonnell, L. R., Ducay, E. D., Sugihara, T. F., and Feeney, R. E. Proteins of chicken, duck, and turkey egg white. *Biochim. et Biophys. Acta*, **13**, 140 (1954).
10. MacDonnell, L. R., Hanson, H. L., Silva, R. B., Lineweaver, H., and Feeney, R. E. Shear—not pressure—harms egg white. *Food Inds.*, **22**, 273 (1950).
11. MacDonnell, L. R., Knight, C. A., Sugihara, T. F., and Feeney, R. E. The chemistry of ovomucin. (In manuscript).
12. MacDonnell, L. R., Lineweaver, H., and Feeney, R. E. Chemistry of shell egg deterioration: Effect of reducing agents. *Poultry Sci.*, **30**, 856 (1951).
13. MacDonnell, L. R., Silva, R. B., and Feeney, R. E. The sulfhydryl groups of ovalbumin. *Arch. Biochem.*, **32**, 288 (1951).
14. McNally, E. Relative amount of mucin in thick and thin egg white. *Proc. Soc. Expt. Biol. and Med.*, **30**, 1254 (1933).
15. Smolelis, A. N., and Hartsell, S. E. Occurrence of lysozyme in bird egg albumins. *Proc. Soc. Expt. Biol. and Med.*, **76**, 455 (1951).

# Special Purpose Foods— Some Problems of Development[a]

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(Manuscript received July 16, 1954)

Special purpose foods designed to occupy a prominent place in restricted diets are creating a new revolution in the field of American foods. Already these products have made an impression on the market of a magnitude comparable to those made by frozen foods and by baby foods. Yet most of such special purpose foods have really only been available for some two years.

With the wide variety of foods and food products involved, and taking into account the many different types of restricted diets for which special foods are needed, it is obvious that the possible combinations are practically unlimited. Manufacturers are now recognizing that tremendous potential markets exist and have begun to spend money on research and development in order to capture these markets. Already there is crisp competition for many of the simpler items, and it must be anticipated that such competition will become keener as more companies develop and introduce new and better products.

Prior to a few years ago, such special purpose foods were few in number, relatively simple, and unfortunately associated with fads. Special stores for distributing such foods usually existed primarily on the basis of sales of water packed fruits and vegetables, high-vitamin fortified but practically inedible materials of various sorts, and whatever varieties of "quack" products a part of the population was most interested in at the moment.

An article by Sipple and King *(6)* is well worth reading just for the amusing aspects of various food fads. It includes an amazing list of misinformation about foods; not of the past unfortunately, but actually existing today. If one evaluates this list in terms of the basic human weakness of trying to escape from reality, then it can readily be seen why food fads have existed and will continue to exist until education makes their absurdity apparent.

The increased emphasis on and interest in valid special purpose foods is certainly no accident. For centuries past, medical men have known that dietary restrictions are called for in many organic disturbances. But in the last fifty years there has been a vast expansion of knowledge of what the patient's food intake actually should be and how the modifications could be effected. Contributions have come from many related fields of study, ranging from physiological chemistry and psychology to dietetics and statistics. Now food technology enters the picture, for the mass production

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 28, 1954.

of well designed special items can greatly facilitate dietary management.

## BACKGROUND FACTORS

At the present time more special foods are designed for and being used for low calorie diets than for any other purpose. This is not surprising when one realizes that some 30 to 35 million Americans are overweight. The interest in weight reduction and control encompasses all age groups as the hazards of obesity are emphasized daily by the medical profession and insurance companies through all media of public information.

Somewhat less numerically is the need for low sugar products by diabetic patients. Some five million people are reported to be known diabetics, and it is believed that an equal number of mild and unknown cases exist.

Products low in sodium are important to the doctor in diets that may be prescribed during pregnancy, for certain kidney and heart ailments and in some hypertension cases.

Low fat diets are becoming increasingly common. Closely associated with fat intake is the intake of cholesterol, now being studied in relation to its effect on arteriosclerosis.

One of the most significant factors in modern dietetic work is the increase in the average age of the American population. This increase has affected many of the disease patterns faced by the medical profession. Diseases of middle and advanced age become increasingly important, and diet and dietary restrictions play an important role in their treatment.

In the past a doctor who placed patients on a restricted diet had little help from food processors. To a considerable extent he was forced to depend on efforts the patient made at home, or else to hospitalize the patient to insure, through the labors of the diet kitchen, that his intake was actually what it should be.

A variety of special foods low in calories, say, or in sodium actually could be prepared in the home and combined in a reasonably attractive diet. But the expenditure of effort, time and money is simply too great for most people. The housewife would have to study and experiment, obtain special ingredients and expend much time and labor to turn out varied and appealing menus every day—and usually for just one member of the household. In practice, therefore, even successful home preparation becomes too onerous, and the result, unsatisfactory to doctor and patient alike, is frequently poor adherence to the diet. By contrast, factory prepared special foods offer the patient ready availability with variety, taste appeal, less expense and much less time and effort for preparation. Therein lies the potential market.

The need is not for restrictive foods that are simply edible. They should look like, smell like, taste like and "eat" like conventional foods. For nothing is more firm than eating habits set by 20 or 30 years of daily practice. If the food does not fit habitual taste patterns, the patient's unhappiness offers a constant threat to the success of the diet.

**The central problem.** The problem then is to design a product that minimizes some undesirable feature of a common food, such as its calories or carbohydrates or sodium, while still closely simulating that food. Those who have worked with taste panels are aware of the difficulties of assessing even conventional products. It becomes even more complex with restrictive substitutes. In addition to matching aroma and the four main taste stimuli: sweet, sour, salt and bitter, there are "feeling" sensations to be duplicated, such as roughness, firmness, stickiness and burning sensations.

This creates critical problems in the development of a special purpose food. Trying to replace the characteristic of a single omitted component may require the use of several materials, each of which may introduce further texture and taste responses. This explains why the flavor strength of a food is so important when one attempts to duplicate the conventional article. For example, preparing a product based on the flavor of chocolate is not particularly difficult because the flavor is sufficiently strong to cover slight variations in the taste response effected by replacing certain other constituents, even though they may be bitter in nature.

Just the opposite is found with such a delicate flavor as maple. The taste reponse from maple syrup is greatly influenced by the sweetness and other characteristics of the high sugar content. As this sugar content is reduced and replaced by other components, the delicate maple flavor is covered by side tastes and off tastes introduced by the substitutes. Part of this may well be explained by the physical action of high concentrations of sugar on the hairs of the taste buds *(2)*. The sugar coating may provide a barrier to the saliva, thereby maintaining the sweet taste longer and with more dominance than is the case where an artificial sweetener is used which does not have this physical assistance. Here, the flavors of other components will exert themselves more strongly, and in certain instances become dominant.

This situation also enters the problem of duplicating the sweetness and texture of the conventional syrup packed canned fruit. Several methods of packing are now being used but in general they all use saccharin or Sucaryl[b] or a combination of the two with or without a thickening agent. The artificial sweeteners are used in a wide range of concentrations with a maximum in the final product for Sucaryl of below 0.5% and for saccharin below 0.05%. The amount depends not only on the sweetness level desired but on the product in which it is employed.

There is a great variation in individuals regarding their reactions to these artificial sweeteners. Some are very sensitive to low concentrations of one or the other, others are not.

Although one may find such thickeners as vegetable gums, gelatin, algin derivatives, pectin and cellulose derivatives being used in various types of dietetic products, only the latter two are used to any extent in canned dietetic fruit. It seems reasonable that these thickening agents, besides contributing to the physical appearance of the products, also have an effect on the taste buds somewhat similar to that physical action exhibited by high concentrations of sugar. Yet the overall reaction is different from the sugar and probably can explain an unexpectedly favorable taste reaction many people get to these products—a higher fresh fruit flavor. Perhaps the flavor is less overwhelmed by the high, continuous response of the taste buds to the sugar syrup.

In the matter of special types of vegetable foods, we have a somewhat similar situation. Conventional packs of vegetables include salt and much of the taste response to the product is due to this salt. When this component is omitted in the preparation of water pack vegetables, we lose a great deal of the expected flavor and have actually an entirely new flavor which is much less desirable to the average palate.

Although substitutes for salt are on the market, there is none that duplicates very closely the taste response obtained with sodium chloride. Even though these products do provide something approaching a low level of saltiness, they introduce harsh and bitter side effects. Some of them will not withstand the high pH of and processing required for canned vegetables. The degradation products of such components are most unsatisfactory to taste and show very little promise.

A promising possibility for vegetables seems to be the introduction of a spice or similar strong flavored component. Of course this makes it a different item from the original water pack product but it still may have merit. For example, the addition of a substantial amount of onion or garlic to string beans makes the product more acceptable, but is it still "string beans"? There is a legal question involved regarding the Federal standards for vegetables. Is the product "string beans, spiced or flavored," or do we have a new item "string beans and onions"?

Next to fruits and vegetables, one of the most important and popular groups of special purpose food items is salad dressings. These products are designed primarily for low fat, low sugar and low calorie diets. They owe their importance to the position occupied by salads in menu planning. Because of their high vitamin, mineral and bulk content, it is important that salads be appetizing so that they will be consumed. Nothing is less appetizing than a "dry" salad.

With the exception of the oil from olives, the high calorie oil fraction of salad dressings contributes little to their flavor and can be eliminated. The use of thickeners, spices and vinegars

[b] Cyclamate, Abbott (Sucaryl®).

gives the desirable texture and flavor, and such products have been well received.

Last year artificially sweetened carbonated beverages made a definite impression on that industry. The appeal of low calorie refreshment coupled with parental fear of tooth decay amongst the youthful users prompted a production of some 5 million cases which is expected to be at least doubled during the current year. The problems encountered are similar to those in the other products and have been discussed in recent articles by Sandri *(5)*. Bodying agents are recognized as contributing to the overall flavor reaction and are in common usage in these products.

In considering products suitable for modification, one encounters a problem which becomes somewhat philosophical in nature. Syrup, for example, is usually used only in conjunction with such items as pancakes, waffles, French toast and the like, none of which is particularly low in calories. The fundamental question is then whether or not we are actually effecting any great improvement in the diet by reducing the caloric content of the syrup. Perhaps if the patient is in the habit of eating sweet articles for breakfast and if the syrup contributes half of the calories and we save half the calories in the syrup, then something worthwhile has been accomplished.

A similar question arises with products like carrots and beets prepared without salt: Are we succeeding in offering a "low sodium" item for the diet when these vegetables themselves contain several times as much sodium as other common vegetables *(3)*, or would an occasional serving for the sake of variety justify their use?

Certainly many potentially restrictive foods would not be useful enough in practice to warrant development. It may not be easy to judge the utility of a given item, particularly since the rest of the patient's diet must also be considered. Yet such a judgment is essential, for unless a food has wide applicability, its production and marketing will be too expensive to be practical.

**Legal aspects.** Perhaps the most critical aspect of special purpose foods lies in the legal area rather than in product formulations. In this connection two agencies are of prime importance: the Federal Food and Drug Administration and the Council on Foods and Nutrition of the American Medical Association.

In the beginning the Food and Drug Administration would not grant requests for permits to ship artificially sweetened fruits. This policy has been modified and permits are now issued on a temporary basis for limited quantities of material. These licenses deal only with products for which standards have been established. This brings up a legal point well stated by H. Thomas Austern *(1)* who writes:

"It is the view of some packers that distinctly labelled artificially sweetened canned fruits are not legally subject to the existing canned-fruit standards because they neither purport to be nor are represented as the food for which a standard of identity has been promulgated."

The industry is still operating under these permits although the situation is difficult and clarification is needed.

The Council on Foods and Nutrition of the American Medical Association is vitally interested in these special products and serves an important function in their development and distribution. In limiting their Seal of Acceptance, they serve as a guide in the development and manufacture of these special purpose foods; then when a product is acceptable, they call the attention of the medical profession to its availability.

What of the future? What can we expect? What is to be hoped for? There are great prospects in this field even though many problems must be faced. One obstacle to expansion is the too prevalent marketing of products which lack taste appeal. A consumer who barely manages to choke down one repellent dietetic item will have little enthusiasm for trying others. Technology must meet this challenge as it did the consumer resistance which developed a few years ago toward improperly handled frozen foods.

## LABELLING

Another need is for the correction of misleading and even dangerous advertising and inadequate label information. While most manufacturers are making an honest effort to develop labels that are adequately informative and descriptive, the practices of a few are promoting a loss of confidence which hampers the legitimate growth of these foods. Correction will either be voluntary or by such action as that recently taken by The Federal Trade Commission against some so-called reducing aids. A well designed product is of real value to doctor and patient; it can be and should be advertised and sold honestly.

In labelling, the characteristics of each dietetic item should be presented according to its ultimate usage. If a product is intended as a low sodium food, then it should have a valid sodium declaration. Similarily if a product is designed for low sugar or low calorie diets then complete information for such use should be listed on the label.

The situation on the hexitols should be clarified. For many years these sugar alcohols, sorbitol and mannitol, have been used in the formulation of various products designed primarily for use by diabetics. They are sweet in flavor and owe their value in the diabetic diet to their slow rate of absorption from the gastrointestinal tract *(4)*. Although mannitol is only partially metabolized, the caloric contribution of sorbitol is essentially identical to that of ordinary sugars.

This caloric contribution is not always made clear on the labels of products containing sorbitol in important amounts. For example, there is available on the market today a product which contains 30% sorbitol and is equivalent in calories to 30% sugar. Yet it is prominently labelled "No Sugar," with all that this implies to the uninformed. If the unique characteristics of sorbitol are to be employed in dietary foods, some more satisfactory description, perhaps a "type of sugar," is needed on the label along with an explanation of its properties.

One of the biggest problems faced by a manufacturer is the tremendous divergency in State laws regarding special purpose food products. It is certainly to be hoped that all State laws can and will be standardized to be more in line with those of the Federal Food and Drug requirements.

What can be expected as to new developments? With the wide range of special products which can be useful in restricted diets, nothing limits the future except the imagination of research workers and the financial, promotional and distributive facilities of industry. The ultimate accomplishment will be determined by the effort that each is willing to expend.

## LITERATURE CITED

1. Austern, H. Thomas. The future of mandatory food standards. *Food, Drug, Cosmetic Law Journal*, **9**, 77 (February, 1954).
2. Crocker, E. C. *Flavor*. 1945. McGraw-Hill Book Co., New York.
3. National Canners Association. *Dietetic Canned Foods*. 1953, Washington, D. C.
4. Olmsted, Wm. H. The metabolism of mannitol and sorbitol. *Diabetes*, **2**, 132 (1953).
5. Sandri, R. M. Making good sugar-free drinks. *Food Eng.*, **26**, 79 (May, 1953).
———. Problems in production of dietetic drinks. *National Bottlers' Gazette*, p. 18 (March, 1954).
6. Sipple, H. S., and King, C. G. Food fads and fancies. *J. Agr. Food Chem.*, **2**, 352-4 (1954).

# Sensory Test Methods. II. Effect of Previous Tests on Consumer Response to Foods[a]

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(Manuscript received July 19, 1954)

**The ratings given foods in consumer-type tests are shown to be influenced by the quality of previously tested samples, even though samples are presented singly with a two-day interval between tests. There is a greater tendency for consumers to rate succeeding samples lower rather than higher than the first sample.**

The results of a series of consumer-type tests demonstrate that relatively recent experience with the same food, particularly under the same test conditions, can be a dominating influence in determining consumers' responses to the food.

It has previously been shown that ratings given a food are influenced by the quality of the other samples presented at the same time *(1, 4, 8)*. In the present experiments, the influence of previous samples was noted when samples were presented singly after time intervals varying from a few seconds to two days or more. The possibility of such an influence was recognized by Peryam and Girardot in their publication describing the test used in these experiments *(9)*. They stated that "whenever more than one sample is presented it must be assumed that ratings may mutually influence each other." However, they considered the possibility that the test could be used "to make general predictions, on an absolute basis, about the acceptance level of any food"; and results of tests using rating scales are often interpreted in this way.

The tendency for a judgment upon a single stimulus to be influenced by preceding stimuli not compared with it directly has been recognized by psychologists for many years *(2, 6, 7, 10, 11)*. These investigators showed that stimuli presented singly are not usually considered singly but tend to form a series to the observer. The magnitudes of the stimuli presented at the end of such a series are judged in relation to those of preceding stimuli. Judgments on the first stimulus in the series tend to be merely random, and the observers most often rate this stimulus in the middle of the available scale. Judgments of succeeding stimuli are influenced by prior stimuli, presented under the same conditions, and this influence of prior stimuli becomes apparent in a very short time. Delays for as long as one to five minutes between stimuli have not been found to influence judgments to any great extent.

This investigation of the effect of previous samples on acceptability ratings of foods was initiated because critical examination of the results obtained using this rating scale method to evaluate response to dried eggs indicated that previous samples had influenced ratings of following samples. The first test described in this paper presents typical results from the original experiment on dried eggs that led to the investigations carried out in Tests II, III, and IV. It is, of course, possible that if the consumers were presented servings of normal size as items in typical meals, they might not be influenced as they were in the test situation. However, the tests involved describe conditions under which judgments are influenced by previous samples and indicate the need for care in design and interpretation of such tests.

## METHODS AND MATERIALS

Consumer responses were obtained by a rating-scale method previously described in detail *(5)*. In this method the individual is asked to indicate his reaction to a food in terms of how much he likes or dislikes it. The questionnaire used offers a choice of 9 responses ranging from *like extremely* through a neutral middle response of *neither like nor dislike* to *dislike extremely*. Values from 9 to 1, respectively, are assigned to the rating scale's 9 categories. Results are expressed in terms of mean score for the sample or in terms of percentages of responses falling into each of the nine categories.

In the following tests, each individual received one to 3 samples at a session. Each sample was presented singly, and the individual was asked to record his reaction before he received another sample. The foods used in the first 3 tests were 1-ounce samples of scrambled eggs of varying quality prepared by controlled methods from eggs that differed in quality by reason of processing or storage treatment. The eggs used were as follows: fresh egg (sample A), unstored glucose-free dried egg (sample B), unstored acidified dried egg (sample C), glucose-free dried egg stored for 12 months at 100° F. (sample B′), and acidified dried egg stored for 12 months at 100° F. (sample C′). The preparation of the egg samples has been previously described *(5)*. It is sufficient for this discussion to note that sample A was generally rated higher than sample B, sample B higher than sample C, and sample B′ higher than sample C′. The principal difference among samples A, B, and C was in texture, but there were slight flavor differences. The principal difference between the stored samples (B′ and C′) was in color, but there were also flavor and texture differences. Sample C′ developed a brown color during storage; sample B′ did not change in color. Sample C′ likewise developed more off flavor than sample B′.

**Test I.** Samples B and C or samples B′ and C′ were presented singly in random order, 3 samples at one session. Thus, 2 samples of one egg type and one of the other were presented at each session in one of the following orders: BBC, BCB, CBB, CCB, CBC, BCC. Each of the two egg types was presented before and after the other egg type approximately 50 times for the unstored eggs and also for the stored eggs. Unstored eggs and stored eggs were presented at different times.

Subjects for this test were selected from laboratory personnel and visitors. Omitted were persons with previous training in judging scrambled eggs, and priority was given to those who had the least previous experience in this type of test situation.

**Test II.** Samples A, B, and C were served to each of 54 individuals. All possible orders of presenting the samples (ABC, ACB, BAC, BCA, CAB, CBA) were used an equal number of

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, June 27-July 2, 1954, Los Angeles, Calif.

times. Thus, each sample was served 18 times in each position (first, second, and third). The test subjects were drawn from groups of visitors to the laboratory and new employees who were inexperienced in taste panel work.

**Test III.** Two samples of scrambled egg, A and B, were served to a total of 40 individuals, with a 2-day interval between presentations. Each subject was asked to come twice, 2 days apart. At the first session he received either A or B, and at the second session he received whichever sample he had not tasted previously. There were 20 ratings in each order. The individuals were not instructed to remember the first sample, nor to compare the 2 samples in any way. They were selected from new and inexperienced tasters and others among the laboratory personnel with least experience in this type of test.

**Test IV.** Scrambled eggs and roast turkey were served to 79 judges. These two foods were chosen to represent a somewhat poor sample (scrambled eggs prepared from acidified dried egg stored 3 months at 100° F.) followed or preceded by a good sample of an entirely different nature (freshly roasted turkey). The acidified dried egg used had darkened slightly and had developed some off-flavor during storage at elevated temperatures. Large turkey halves of good quality from a single lot of birds were roasted uncovered in an electric oven to an internal thigh temperature of 185° F. The skin was removed and the breast, thigh, and drumstick were sliced onto hot covered platters. Each serving of turkey consisted of both light and dark meat. Forty of the individuals received the egg sample first, followed by turkey, and 39 received the foods in the opposite order.

Test subjects were selected from among the laboratory personnel who had no previous tasting experience, who had tasted scrambled eggs only once before, or who had not served on the consumer type preference panel for scrambled eggs in the previous 18 months.

## RESULTS

**Test I.** (Samples B and C presented singly in varying order, 3 samples at a session; samples B′ and C′ presented in the same manner.) Separation of the ratings for sample C into two groups, group I in which C was tested (in position 1 or 2) before B and group II in which C was tested (in position 2 or 3) after B, showed a distinct difference that was apparently due to the order of testing. Sample C tested before B was given a mean rating of 6.8, and tested after B a rating of 5.9. When these dried egg samples were stored for 12 months at 100° F. the same difference between groups occurred. The mean rating for C′ tested before B′ was 4.5 and when tested after B′ was 3.5. In both cases the differences in ratings are statistically significant ($P = 0.05$). Of particular interest are the changes in the distribution of ratings given to C before and after testing of B (Figure 1). For the unstored samples tested after B there was a decrease in ratings in the *like* categories, and the greatest increase occurred in ratings at the level of 4, described as *dislike slightly*. For the stored samples, the greatest increase occurred in ratings at the level of 1, described as *dislike extremely*. Only 6% of the individuals gave C′ a rating of 1 when it was tested before B′, but 29% gave it that rating when it was tested after B′.

The ratings of B and B′, on the other hand, varied only from 6.2 to 6.6 whether they were tested before or after C and C′. The ratings were not higher after previous testing of C and C′ than they were before testing of C and C′, suggesting the possibility that the consumers were more critical of samples tested in the second and third positions than of those in the first position.

The results of this test indicated the need for further tests to elucidate some of the factors that were influencing the consumers in their rating of samples. These were (a) the influence of previous samples on the ratings, and (b) the apparent tendency of the test subjects to be more critical of samples tested after the first sample.

**Test II.** (Samples A, B, and C presented singly in varying order, 3 samples at a session.) The results of this test demonstrate that previous testing of high-quality samples can lower the ratings of medium and low quality samples, and previous testing of medium and low quality samples can raise the ratings of high quality samples. It also shows that in a series of samples presented singly in the same session, the most recently tested

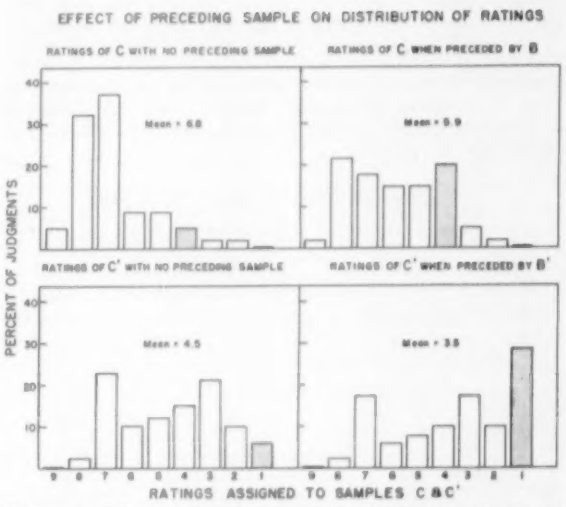
EFFECT OF PRECEDING SAMPLE ON DISTRIBUTION OF RATINGS
RATINGS OF C WITH NO PRECEDING SAMPLE
RATINGS OF C WHEN PRECEDED BY B
RATINGS OF C' WITH NO PRECEDING SAMPLE
RATINGS OF C' WHEN PRECEDED BY B'
Mean = 6.8
Mean = 5.9
Mean = 4.5
Mean = 3.5
PERCENT OF JUDGMENTS
RATINGS ASSIGNED TO SAMPLES C & C'

**Figure 1. Effect of preceding sample on distribution of ratings.**

sample exerts the greatest influence on the rating of a following sample.

When samples A, B, and C were presented singly at the same session, A received the highest mean rating (6.8), B the next highest (5.7), and C the lowest (5.1) (Figure 2). Grouping of the ratings for each sample according to the order in which the samples were tested shows that the order strongly influenced the rating. The trend is in the expected direction in each case, with increasingly higher ratings for the best sample (A) and lower rating for the medium (B) and low (C) quality samples. Sample A received its lowest rating when it was the first sample tested and its highest rating when it was the third sample tested. Samples B and C, on the other hand, received their highest ratings when they were tested first; and their ratings became progressively lower when they were tested second and third. The 3 ratings in order of testing for A were 6.5, 6.6, and 7.3; for B they were 6.2, 5.8, and 5.2; for C they were 5.9, 5.2, and 4.3 (Figure 2). The change in ratings for sample C is statistically significant.

This change in ratings from first to third position is evidently due to the influence of preceding samples on the ratings assigned to samples tested in second or third positions (Figure 3). A

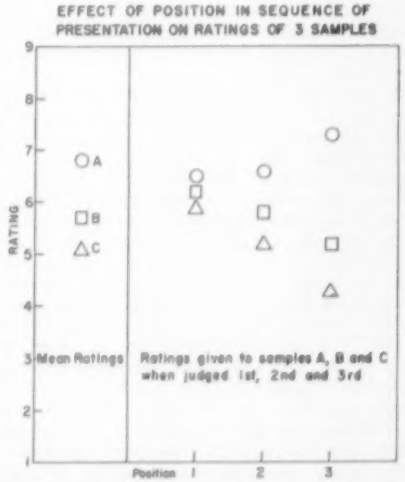
EFFECT OF POSITION IN SEQUENCE OF PRESENTATION ON RATINGS OF 3 SAMPLES
RATING
A
B
C
Mean Ratings
Ratings given to samples A, B and C when judged 1st, 2nd and 3rd
Position 1 2 3

**Figure 2. Effect of position in sequence of presentation on ratings of 3 samples.**

single preceding sample affects the rating of the following sample less than do two preceding samples. Thus, the ratings for A in the first and second positions do not differ significantly. The ratings for B and C in the second position do not differ from their ratings in the first position when preceded only by C or B. Previous testing of A, however, lowers the rating of B from 6.2 to 5.3 and C from 5.9 to 4.2. The latter difference is statistically significant.

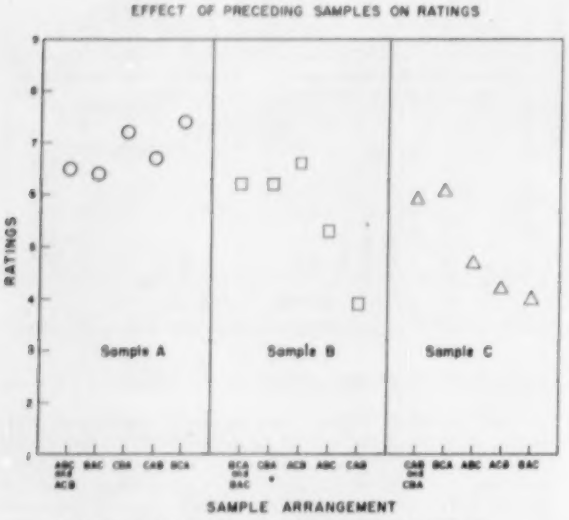


**Figure 3. Effect of preceding samples on ratings.**

The strongest influence on the samples tested in the third position is exerted by the sample in the second position. This is illustrated by the ratings for B in the third position following both A and C. When the samples were presented in the order A-C-B, the strongest influence on B was that of C and the rating of B was 6.6; when they were presented in the order C-A-B, the strongest influence was that of A and the rating of B was lowered significantly from its first-position rating of 6.2 to 3.9. A similar influence was observed for the rating of C in the third position. Since A has a higher mean rating than B, it is not surprising that A is more effective than B in lowering the rating of C. The influence of A predominates when the samples are presented in the order B-A-C and in this case the rating for C was 4.0, a rating significantly lower than its first-position rating of 5.9. The influence of B predominates when the samples are presented in the order A-B-C, and the rating for C was 4.7, a rating that is lower but not significantly lower than its first-position rating.

**Test III.** (Samples A and B presented with two-day interval between them.). The results of this test demonstrate that the influence of preceding samples is evident even when 2 days elapse between tests. Thus, the consumers not only rate a test food by comparing it with previous samples of the same food, but under somewhat artificial surroundings of the test situation they compare a food with previous samples of the same food tasted under the same conditions. There is also further indication that consumers tend to be more critical of the samples tested following the first sample than they are of the first sample.

When tests of A and B were separated by a two-day interval, the rating for A, including results of both days' testings, was 7.4; and that of B was 6.9 (Figure 4). However, the panel receiving A on the first day and B two days later gave A a rating of 7.2 and B a rating of 6.0, a difference in ratings that is statistically significant. The superior quality of A evidently influenced this group in their rating of B, and the comparison resulted in a lower rating for B. The panel receiving B on the first day and A two days later gave essentially the same ratings to both, 7.7 to B and 7.6 to A. Failure of this group to rate A higher than B probably results from the combined effect of two factors. One is a tendency to avoid giving any sample the highest rating, 9, described on the rating sheet as *like extremely*, thus decreasing the likelihood of mean ratings significantly higher than the 7.7 given to the first sample tested. The other is the tendency to develop a more critical attitude after testing the first sample, a tendency noted also in Test I.

**Test IV.** The ratings given to roast turkey and scrambled eggs (sample C stored 3 months at 100° F.) presented in opposite order to two groups of consumers did not show any difference with respect to order of tasting. The group receiving the turkey first rated the turkey 7.5 and the egg 6.4; the group receiving the egg first rated the egg 6.2 and the turkey 7.4. Thus, for these two foods this test showed no influence of previous testing of a good sample of one food on the rating of a rather poor sample of another and vice versa.

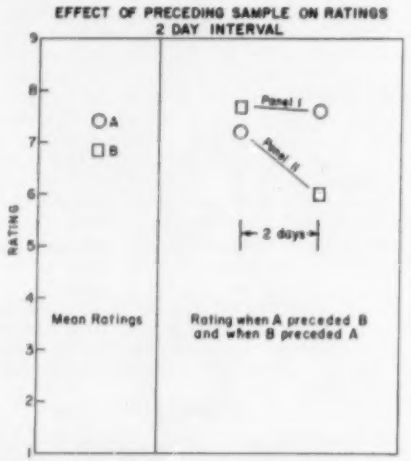


**Figure 4. Effect of preceding sample on ratings, 2-day interval.**

## DISCUSSION

The results of these tests, which reveal the marked influence of previous samples on the ratings given to following samples, have some important implications for the interpretation of consumer tests. The consumer's attitude toward the first sample appears to be one of caution and an unwillingness to use the extremes of the rating scale. This "error of caution," a tendency to avoid giving extreme judgment, is mentioned by Guilford *(3)* in his discussion of errors in rating. The attitude toward the second and third samples is apparently influenced by a combination of effects. First, there is the comparison with the previous sample, causing the consumer to consider whether the following sample is better or worse than the previous sample rather than how well he likes the sample in terms of an absolute scale *(11)*. Second, there is apparently an increase of discrimination with repetitive testing, and third, there is an increased willingness to use the extremes of the rating scale although this effect is most apparent as an increased willingness to use the lower extreme of the scale.

These effects are, of course, interrelated. For instance, if the first sample the consumer is asked to rate is of satisfactory quality, he is apt to decide that he likes it but does not want to commit himself too strongly and rates it in the middle of the *like* category, a rating of 7. On the following sample the question intrudes as to whether it is better or worse than the previous sample. If it is better, there are only two ratings higher than 7

and there is some conflict as to whether the judge wants to show that the sample is better or whether he does not want to commit himself so strongly in regard to how much he likes it. On the other hand, if the following sample is worse, then 6 ratings below 7 are available and there is little or no conflict. The increase of discrimination with repetition is probably due in part to the use of a greater portion of the rating scale in order to show differences detected. However, the consumers also tend to become more critical. This is shown by the fact that when two samples of intermediate quality are rated, there is more tendency to rate the poorer sample lower following the better sample than to rate the better sample higher following the poorer sample.

It is apparent that ratings for a food obtained under test conditions requiring rating of several samples of the food must be considered as reflecting in large degree the relative preferences for the various samples tasted rather than the desirability of the samples referred only to the non-panel experience of the taster. Presentation of only a single sample of any one kind of food might be considered a possible solution to the problem of avoiding the influence of previous samples of the same food. However, it seems probable that a single sample of a food tested under laboratory conditions may actually give a poor indication of consumers' reactions to the foods under usual conditions. The distinctive characteristics of a food are apparently evaluated with greater discrimination after tasting of previous samples of varying quality just as judgments of single stimuli in a series show greater discrimination after extreme members of the series have been presented *(11)*. Thus the reaction to a single sample of a food served in a test situation may be considerably different from the reaction to the food under conditions of normal usage. This possibility would appear to be most serious in samples for which a substantial portion of the consumers express a slight dislike at the first tasting, since results of these tests indicate that with further experience this slight dislike would probably be intensified.

## CONCLUSIONS

Consumer-test ratings of foods are influenced by previously tested samples of the same food even though the samples are presented singly. This influence occurs when two days elapse between testing of samples as well as when the time interval is only a few minutes. There is a greater tendency for succeeding samples to be rated lower rather than higher than the first sample. This tendency is apparently the effect of development of a more critical attitude on the part of the judges with continued testing. Where consumer panel members taste more than one sample of a food, the ratings given are, therefore, preference ratings for the samples tasted and do not show reliably how much the food is liked or disliked. This demonstration of the influence of previous samples on consumer response to foods thus indicates that tasting experience of a consumer is more important than was previously supposed and that the planning and interpretation of experiments must take this fact into consideration.

## LITERATURE CITED


1. Dove, W. F. The relative nature of human preference, with an example in the palatability of different varieties of sweet corn. *J. Comp. Psychol.*, **35**, 219 (1943).
2. Fernberger, S. W. Interdependence of judgments within the series for the method of constant stimuli. *J. Exp. Psychol.*, **3**, 126 (1920).
3. Guilford, J. P. *Psychometric Methods.* 2nd ed. 1952. D. Van Nostrand Co., New York, N. Y.
4. Hanson, H. L., Kline, L., and Lineweaver, H. Application of balanced incomplete block design to scoring of ten dried egg samples. *Food Technol.*, **5**, 9 (1951).
5. Hanson, H. L., and Kline, L. Consumer-type appraisal of whole egg powders stabilized by glucose removal (yeast fermentation) and acidification. *Food Technol.*, **8**, 372 (1954).
6. Harper, R. Psychophysical relationships and their study. *Research*, **3**, 350 (1950).
7. Hollingworth, H. L. Experimental studies in judgment. *Archives of Psych.*, No. 29 (1913).
8. Hopkins, J. W. A procedure for quantifying subjective appraisals of odor, flavor, and texture of foodstuffs. *Biometrics*, **6**, 1 (1950).
9. Peryam, D. R., and Girardot, N. F. Advanced taste-test method. *Food Engin.*, **24**, 58 (1952).
10. Volkmann, J. The method of single stimuli. *Amer. J. Psychol.*, **44**, 808 (1932).
11. Wever, E. G., and Zener, K. E. The method of absolute judgment in psychophysics. *Psychol. Rev.*, **35**, 466 (1928).

# The Effect of Concentration on Quality of Frozen Orange Juice with Particular Reference to 58.5° and 42° Brix Products. I. Chemical and Physiological Aspects[a]

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(Manuscript received July 13, 1954)

**The effect of concentration on the quality of frozen orange juice is studied. Data on flavor and cloud retention, vitamin C retention, viscosity and freezing characteristics are presented and compared with particular reference to 58.5° and 42° Brix products (Part I). The effect of concentration on the growth and survival of various strains of off-flavor producing bacteria and osmophilic yeasts is reported in Part II.**

Retention of quality in frozen concentrated orange juice during packing, transportation, storage, and marketing has received considerable attention in the past few years during the phenomenal growth of the industry. The chief problem has been the maintenance of the cloud, flavor and product character in marketing channels.

Cloud retention of citrus juice is an extremely important commercial factor as demonstrated by several workers *(5, 9)* who have reported that temperature of storage had a pronounced effect on stability of frozen concentrated orange juice made from non-heat-stabilized juice, pointing out that low temperature storage of 0° F. or below was essential in maintaining flavor and cloud for long storage periods.

Later, as a result of our own work and that of others *(1, 3, 7)* it has been shown that a controlled heat treatment aids in further stabilization of the concentrate by inactivation of most of the pectic enzyme which causes the loss of cloud. Some workers have suggested temperature as high as 190° F. for the heat stabilization *(13, 14)*. Many Florida packers have now adopted the heat stabilization or blanching procedure. The usual practice is to flash heat the juice either as it enters the evaporators or early in the process of concentration at a temperature of beween 150 and 160° F. for 5-15 seconds, followed by a rapid cooling in a heat exchanger or by flashing to the evaporator. It has been observed that such temperatures, when properly controlled, do not adversely affect the flavor, but that higher temperatures do.

Cotton *et al. (4)* studied clarification rates of orange concentrate[d] stored fifteen months at 0° F. (at 51° Brix) and held four days at 40° and 80° F. at concentrations of 51°, 42°, 25° and 11.5° Brix. These workers found that the reconstituted juice from the 25° Brix product was the least stable while that from 42° Brix was next least stable. The juices from the 11.5° and 51° Brix samples were considerably more stable than the other two.

Rouse *(11)* reported that in orange concentrate the greatest pectinesterase enzyme activity occurred at 41° Brix. Rouse *(12)* found that when pulp particle size of Valencia juice was reduced or more finely divided there was a greater pectinesterase activity. Wenzel *et al. (15)* in studying clarification of orange concentrate at various concentrations, indicated that juice clarified most readily in the range between 32.3 and 41.4° Brix. Huggart *(6)* reported that clarification of orange concentrate occurred at a faster rate between 18 and 51° Brix and only that which was concentrated above 70° Brix was stable during three months' storage at 40° F.

Studies in these laboratories indicate that as the concentration increases above 42° Brix, the more stable is the product as determined by cloud and flavor determinations. These results have been substantiated recently by Rice *et al. (10)*. In 1953 a commercial pack of a 58.5° Brix or 6-fold orange concentrate was made for the U. S. Navy after their having tested a similar laboratory pack. Several factors were taken into consideration in selecting this point of concentration. First, since the container is used as a measure for water added in reconstitution, the concentration of the product should require a whole or non-fractional number of units to assure uniformity in reconstitution of the product to be consumed. Second, the initial concentration of such a product must be sufficiently high to permit the addition of enough fresh juice to give the final product the desired flavor, yet not so high as to be uneconomical. Third, the product must not be of such viscosity that the consumer cannot reconstitute it quickly and easily.

## EXPERIMENTAL PROCEDURE

**Preparation of samples.** The concentrates used in these studies were made by conventional commercial procedures. As nearly as possible, all fruit of one variety was from the same lot. Pineapple and Valencia oranges were washed by mechanical brushes utilizing a detergent, sprayed with a germicidal solution, rinsed with fresh water and extracted by mechanical reamers. The juice was then passed through a finisher with an 0.027 inch screen and pumped to cold wall supply tanks from which the evaporators were fed. It was concentrated in conventional evaporators at 15-20 mm. of pressure to the desired level of concentration and cut back to the finished level with fresh juice. The finished soluble solids levels were 58.5° Brix and 42° Brix. The orange oil contents of all the finished concentrates were

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[d] Unless otherwise stated, references to "orange concentrate" assume that the product is not heat treated.

standardized at 0.01% on a reconstituted basis, an accepted practice of the industry.

**Stabilization.** Stabilization of the juice consisted of flash heating it at 150° F. for approximately 10 seconds between stages of concentration at 18° Brix. The non-stabilized samples were made from juice that was fed directly from the cold wall tanks to the evaporator without heat treatment.

**Storage.** Test samples were stored at temperatures of 80, 60, 40, 15 and 0° F. but for this report only 80, 60 and 40° F. have been considered because more time is necessary to obtain full data from samples stored at the lower temperatures. Water baths controlled to ± 1° F. were used to provide the temperatures of 80 and 60° F. The 40° F. temperature was provided by using a refrigerated room controlled to ± 1° F. Temperatures of 15° F. and 0° (± 1° F.) were attained by the use of small, double-walled Celotex cabinets of 5 cu. ft. capacity previously described *(5)*. Control samples were stored in a refrigerated warehouse at —10° F.

**Sampling.** A large number of samples of concentrate were packed in 6-ounce cans and stored in order that an adequate supply would be available for all the examinations planned.

At specific intervals cans of each product were taken from the particular storage for examinations. Samples stored at the higher temperatures were examined at more frequent intervals than were those at the lower levels. When the samples stored at specific temperatures were judged undesirable in flavor or had completely separated, the examinations were terminated.

## RESULTS AND DISCUSSION

**Flavor and cloud retention.** Since the presence in juice of finely divided, suspended particles (cloud) has been established as a criterion of stability of concentrated orange juice, optical density determinations converted to light transmission were made using a Lumetron No. 200 photoelectric colorimeter with filter No. 650. Before taking these readings, the juices were reconstituted to 12° Brix and centrifuged at 1325 r.p.m. for 10 minutes in an International Type SB centrifuge. The supernatant liquid was decanted and its optical density in terms of light transmission was read on the instrument. When, as a result of storage conditions, the light transmission of the samples excedeed 50%, it was arbitrarily judged unacceptable from the consumer standpoint.

At the same time the cloud determinations were made, flavor ratings were also made by three experienced judged who tasted the reconstituted juices and rated them as to whether or not they were acceptable as market products.

The results of the cloud determinations of the 4 orange juice concentrates as affected by storage temperatures of 40° and 80° F. are shown in Figures 1 and 2. In every instance the stabilized (heated) products retained their acceptability longer than the non-stabilized (unheated). The cloud was considerably more stable in the 58.5° Brix products than in the 42° Brix products

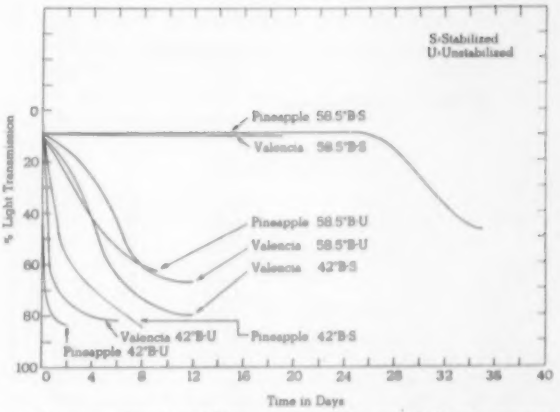


**Figure 1. Cloud stability of pineapple and Valencia concentrated orange juice of 42° and 58.5° Brix stored at 40° F.**

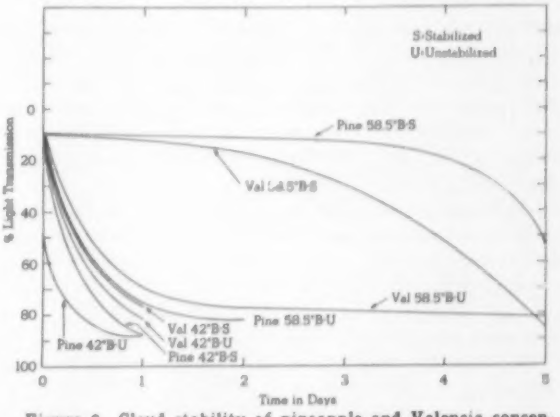


**Figure 2. Cloud stability of pineapple and Valencia concentrated orange juice of 42° and 58.5° Brix stored at 80° F.**

stored at the same temperature. Those samples stored at 60° F. showed the same relative pattern, but at the higher temperature the time required for degradation was less than for those held at 40° F. It is known that in non-stabilized 42° Brix orange juice stored at 0° F., the light transmission changes little in 10 months *(5)*. It follows that 58.5° Brix concentrated orange juice stored at 0° F. should retain its cloud well for a considerably longer period.

Figure 3 shows typical relationships of cloud and flavor acceptability of 42° and 58.5° Brix products stored at 80°, 60°, and 40° F. The cloud of the 42° Brix product was less stable than its flavor, while the reverse was true of the 58.5° Brix juice. These results

**TABLE 1**

**Analysis of storage samples**

| Analysis | Pineapple | | | | Valencia | | | |
|---|---|---|---|---|---|---|---|---|
| | Unstab. | Stab. | Unstab. | Stab. | Unstab. | Stab. | Unstab. | Stab. |
| ° Brix | 41.9 | 41.6 | 58.1 | 57.9 | 41.8 | 42.7 | 57.9 | 57.9 |
| Citric Acid % by Weight | 2.64 | 2.6 | 3.66 | 3.62 | 2.84 | 2.84 | 3.80 | 3.74 |
| Brix/Acid Ratio | 15.9 | 16.0 | 15.9 | 16.0 | 14.6 | 15.0 | 14.2 | 15.4 |
| % Light Transmission | 83.5[1] | 18.5 | 29.0 | 11.0 | 16.0 | 15.0 | 14.0 | 11.5 |
| PEU[420-4m1./°Brix] | 5.31 | 2.47 | 5.4 | 1.61 | 3.58 | 1.33 | 3.72 | 1.42 |
| % Pulp—Reconstituted Basis | 16.0 | 14.0 | 14.0 | 14.0 | 12.0 | 14.0 | 12.0 | 12.0 |

[1] Separation caused by high enzyme activity and inadvertent delay in freezing.

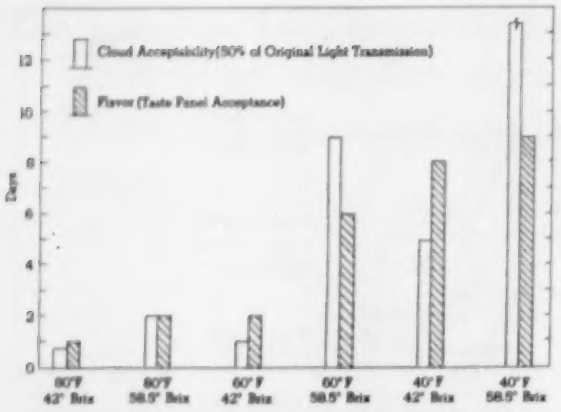


**Figure 3. Flavor and cloud acceptability of 42° and 58.5° Brix concentrated Valencia orange juice (stabilized) stored at 40°, 60° and 80° F.**

demonstrate that, from a practical viewpoint, the cloud stability is a better index of market acceptability of 42° Brix juice, while flavor is a better index for the 58.5° Brix product. The heat treatment not only improves cloud stability, but also improves flavor stability to a lesser extent. It is further shown that there is greater flavor stability in 58.5° over the 42° Brix juice.

Although the data presented above indicate that both mild heat treatment and high concentration contribute to greater stability of flavor and cloud in concentrated orange juice, it must be emphasized that maximum storage temperatures should never exceed 0° F. for retention of quality.

**Vitamin C.** Vitamin C determinations were made according to the dye method of Bessey and King *(2)*, modified for orange juice. Marshall *(8)* found that there was practically no loss of vitamin C during the normal preparation and processing of concentrated orange juice. He also demonstrated that at 0° F. storage, the vitamin C loss in 42° Brix concentrate was very small, amounting only to *2%* during nine months of storage. At 40° F. the loss was 3% in a two week period. At 75° F. after one week at which time the concentrate had fermented, the loss was only *7%*.

Vitamin C determinations were made on the 42° and 58.5° Brix stabilized and 58.5° non-stabilized concentrate stored nine days at 40° and 60° F. The retention of vitamin C in Valencia concentrate is shown below:

| Product | % Retention | |
|---|---|---|
| | 40° F. storage | 60° F. storage |
| 58.5° Brix unstabilized | 92.2 | 88.0 |
| 58.5° Brix stabilized | 93.9 | 90.1 |
| 42° Brix stabilized | 86.1 | ..... |

These results indicated that there was a slightly greater loss in the 42° Brix than in the 58.5° Brix juice. Nevertheless, a high percentage of vitamin C is retained even after undesirable changes have occurred in the cloud and flavor as a result of storage at damaging temperaures.

**Viscosity.** Any instrument used to measure viscosity in concentrated orange juice should be capable of measuring through the wide range of concentration, pulp levels, and temperatures encountered. Many types of viscometers have been tried, most of which, for one reason or another, were not adapted to making these measurements. The Brookfield S-L Viscometer Model LVT proved to be best adapted for measuring the viscosity in concentrates. However, even this instrument must be operated at one speed using one specific spindle in order to obtain relative readings. Changes in speeds or in spindles result in readings that are not comparable. Because of their pulp contents, orange juice and its concentrates cannot be regarded as true solutions. Viscosities of such liquids, accordingly, are expressed in terms of "apparent" rather than true viscosity. As demonstrated in Figure 4, the pulp content of concentrated orange juice affects the viscosity considerably. Figure 5 shows the relationship of temperature to viscosity in 42° and 58.5° Brix concentrates.

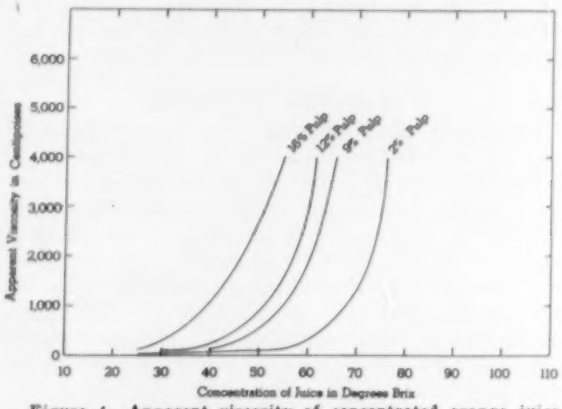


**Figure 4. Apparent viscosity of concentrated orange juice at pulp levels of 2, 9, 12, and 16%.**

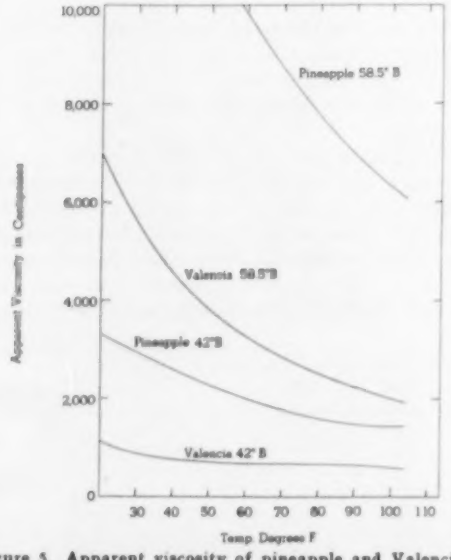


**Figure 5. Apparent viscosity of pineapple and Valencia 42° and 58.5° Brix concentrated orange juice (stabilized).**

These results indicate the importance of the role of pulp, concentration, and temperature on the viscosity of concentrated orange juice.

**Freezing characteristics.** The freezing characteristics of concentrated orange juice are also an important factor in its handling both by the processor and the consumer. Freezing point determinations were made using a refrigerated alcohol bath provided with a 50 cc. beaker containing the concentrate. The concentrate was stirred slowly and the temperature recorded at the point at which crystals appeared and the slope of the temperature curve changed. The procedure was then reversed and the temperature of thawing product was noted. In most true solutions, thawing and freezing temperatures coincide; however, concentrate does not behave as a true solution. Figure 6 illustrates the two curves obtained. These are compared with the freezing points of sucrose solutions at the same concentrations.

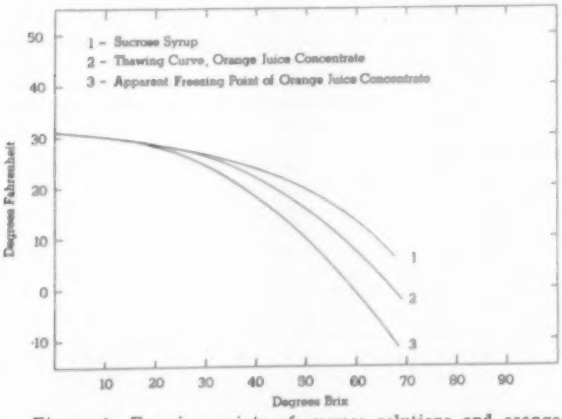


**Figure 6. Freezing points of sucrose solutions and orange juice at various concentrations.**

## SUMMARY

Commercial packs of 58.5° Brix concentrated orange juice have been made successfully. A 58.5° Brix (6-fold) product was chosen because it fulfilled all requirements of practicability such as ease of reconstitution, stability of cloud and flavor, and efficient manufacture.

The cloud of 58.5° Brix concentrated orange juice with pulp content of 10-12% stored at 80°, 60°, and 40° F. was considerably more stable than that of 42° Brix concentrate. Heat stabilized concentrate is more stable than non-heat stabilized concentrate. Flavor stability of 42° Brix products is greater than their cloud stability, while, on the other hand, cloud stability of 58.5° Brix orange juice exceeds its flavor stability. The flavor stability of 58.5° Brix juice was greater than that of 42° Brix. Thus, cloud stability can be used as an index of quality of 42° Brix product, while flavor stability should be used as the primary index for 58.5° Brix product quality.

Vitamin determinations indicate that vitamin C is highly stable in 58.5° Brix product. Viscosity and freezing data are presented.

### Acknowledgment

The authors wish to thank Dr. W. R. Roy and Mr. C. H. Brokaw for their encouragement and advice and also Messrs. J. R. Marshall, C. B. Clark, J. L. Froscher, who assisted so capably in performing the analyses.

## LITERATURE CITED

1. Atkins, C. D., Rouse, A. H., Huggart, R. L., Asbell, Dorothy M., Wenzel, F. W., Moore, E. L., and Olson, R. W. Heat treatment of Pineapple orange, Valencia orange and Duncan grapefruit juices prior to concentration. Second Annual Citrus Processors Meeting. Lake Alfred, Florida Citrus Exp. Station. *Mimeo. report.* (10/9/51).
2. Bessey, O. H., and King, C. G. The distribution of vitamin C in plant and animal tissue and its determination. *J. Biol. Chem.*, **103**, 687-698 (1933).
3. Bissett, O. W., Veldhuis, M. K., and Rushing, M. K. Effect of heat treatment temperature on the storage life of Valencia orange concentrates. *Food Technol.*, **7**, 258 (1953).
4. Cotton, R. H., Roy, W. R., Brokaw, C. H., McDuff, O. R., and Schroeder, A. L. Storage studies of frozen citrus concentrates. *Proc. Fla. State Hort. Soc.*, 39-49 (1947).
5. DuBois, C. W., and Kew, T. J. Storage temperature effects on frozen citrus concentrates. *Refrig. Eng.*, **59**, 772-812 (1951).
6. Huggart, R. L. Effect of concentration on clarification in concentrated citrus juices. *Proc. Fla. State Hort. Soc.*, 237-242 (1952).
7. Keller, G. J., Rice, R. G., McColloch, R. J., and Beavens, E. A. Stabilization of frozen citrus concentrates by heat treatment. *Food Technol.*, **8**, 195 (1954).
8. Marshall, J. R. Retention of ascorbic acid in citrus concentrates during storage at various temperatures. (Thesis, Depart. of Food Technol., U. of Mass., Amherst, Mass., 1951).
9. Moore, Edwin L., Huggart, R. L., and Hill, E. C. Storage changes in frozen concentrated citrus juices. Preliminary report. *Proc. Fla. State Hort. Soc.* 165 (1950).
10. Rice, R. G., Keller, G. J., McColloch, R. J., and Beavens, E. A. Fruit concentrates flavor fortified high density frozen citrus concentrates. *J. Ag. Food Chem.*, **2**, 196 (1954).
11. Rouse, A. H. Gel formation in frozen citrus concentrates thawed and stored at 40° F. *Proc. Fla. State Hort. Soc.*, 170 (1949).
12. Rouse, A. H. Effect of insoluble solids and particle size of pulp on the pectinesterase activity of orange juice. *Proc. Fla. State Hort. Soc.*, 162 (1951).
13. Rouse, A. H., and Atkins, C. D. Heat inactivation of pectinesterase in citrus juices. *Food Technol.*, **6**, 291 (1952).
14. Stevens, J. W., Pritchett, D. E., Baier, W. E. Control of enzymatic flocculation of cloud in citrus fruits. *Food Technol.*, **4**, 469 (1950).
15. Wenzel, F. W., Moore, E. L., Rouse, A. H., and Atkins, C. D. Gelation and clarification in concentrated citrus juices. I. Introduction and present status. *Food Technol.*, **5**, 454 (1951).

# The Effect of Concentration on Quality of Frozen Orange Juice with Particular Reference to 58.5° and 42° Brix Products. II. Bacteriological Aspects[a]

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(Manuscript received July 13, 1954)

Sporadic occurrence of spoilage characterized by off flavors and odors similar to buttermilk was first encountered by the concentrate industry during the 1949-50 season. This type of spoilage in concentrate has resulted in considerable economic losses to the industry. The organisms responsible for the initial outbreaks of spoilage were isolated by Hays *(3)* and were identified as *Lactobacillus brevis* and *Lactobacillus plantarum*. Murdock *et al. (5)* and Hays and Riester *(4)* noted that certain other organisms belonging to the genera *Leuconostoc* in addition to *Lactobacilli* were also responsible spoilage bacteria.

Yeasts have been of little or no economic importance as spoilage agents in the production of frozen concentrated orange juice. The trend to high Brix concentrate (58.5° to 70° Brix) may reduce spoilage problems due to off-flavor producing bacteria because of their lower tolerance to high sugar solids *(2, 6)*; however, spoilage due to osmophilic yeasts may still exist. For example, the Research Department of the Continental Can Company, Inc. *(1)* has isolated four species of yeasts capable of growing in 65° Brix orange concentrate.

Faville *et al. (2)* studied the survival of pure cultures of yeasts and bacteria in single strength orange juice and in 42° Brix orange concentrate. They reported that *Leuconostoc mesenteroides* did not increase in numbers in single strength orange juice after seven hours incubation at 30° C. The yeast strains, however, increased tenfold during the same period. In the 42° Brix concentrate *L. mesenteroides* died off rapidly while the yeasts were unaffected, neither dying nor multiplying. Recca and Mrak *(8)* investigated the growth of 92 yeast cultures in orange concentrate of various sugar concentrations ranging from 35 to 65° Brix. They noted that only a few strains were capable of growing in 65° Brix orange concentrate. In order to obtain additional information on the effect of concentration on the growth and survival of various strains of off-flavor producing bacteria and osmophilic yeasts, it was decided to investigate further these phases of the problem.

## EXPERIMENTAL PROCEDURE

Three composite stock suspensions were prepared consisting of (a) 4 strains of *Leuconostoc sp.* and one strain of *Leuconostoc mesenteroides*,[b] (b) 3 strains of *Lactobacillus sp.* and one strain each of *Lactobacillus brevis*, and *Lactobacillus plantarum*,[b] and (c) of osmophilic yeasts consisting of 4 strains of *Saccharomyces rouxi* and one strain of *S. acidfaciens*.[c] All test strains were originally isolated from citrus products and are believed to be typical of what is found in normal orange juice processed under commercial conditions. The isolates were grown on orange serum agar slants prepared in 8-ounce screw cap bottles and incubated 48 to 72 hours at 86° F. (30° C.). Each slant was washed with 10 ml. of sterile water and the suspensions combined in sterile bottles with glass beads to form the respective composites.

The number of organisms present in each suspension was determined by making plate counts on orange serum agar after 72 hours at 86° F. The suspensions were stored in the refrigerator when not in use.

The survival of the test organisms at 0°, 15°, and at 40° F. was determined in 42° Brix (pH 3.75, total acidity 2.74%), 58.5° Brix (pH 3.75, total acidity 3.75%), and 70° Brix (pH 3.76, total acidity 4.75%) Valencia orange concentrate. The 70° Brix concentrate was adjusted with water to the Brix levels indicated. A small Hobart mixer, thoroughly washed and sterilized with chlorinated water, was used to mix the concentrate which was inoculated with a known quantity of each composite suspension. The inoculated product was packed in 6-ounce cans, closed and stored at 0, 15, and 40° F. Control samples from each batch of concentrate were plated before and after inoculation. One can from each variable of samples inoculated with yeasts was plated on orange serum agar each day for 21 days, while the cans inoculated with *Leuconostoc* and *Lactobacillus* were plated twice per week over the same period. After 3 weeks, all samples were plated weekly up to 8 weeks. All plates were counted after 72 hours of incubation at 86° F.

The effect of concentration on the growth of the test organisms at 75° F. was ascertained in 12, 20, 30, 42, 58.5 and 70° Brix orange concentrate. These levels of concentrate were obtained by adjusting the 70° Brix concentrate with water. The concentrate in bottles with glass beads was sterilized in flowing steam, cooled, and inoculated with a known quantity of the composite suspensions previously described. Each sample of a given degree Brix was plated from the same bottle on orange serum agar at 6-hour intervals up to 60 hours, and again at 72 hours.

**Bacteriological results.** The survival curves of the strains of *Leuconostoc, Lactobacillus,* and yeast in 42° Brix orange juice at 0° F. and 15° F. are presented in Figure 1. The growth characteristics of the yeast at 40° F. are also shown. The data for the bacteria at this temperature have been deleted due to the growth interference of yeasts, which were present in the concentrate as natural contaminants in a low concentration of less than 100 per g. In Figures 2 and 3 are shown the survival curves for the test organisms in 58.5° and 70° Brix concentrates respectively, at the temperatures indicated. The results show the greatest reduction in numbers occurs in most cases during the first ten days of storage. After this period, the reduction in total count becomes more gradual. Of the test organisms investigated, the yeasts survived in larger numbers than did the bacteria. Patrick *(7)* also noted that of the spoilage

[a] Presented in conjunction with Part I at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

[b] Received from Research Dept., Continental Can Co., Inc., Chicago, Ill.

[c] Received from Dr. Jack A. Recca, Univ. of Calif., Davis, Calif.

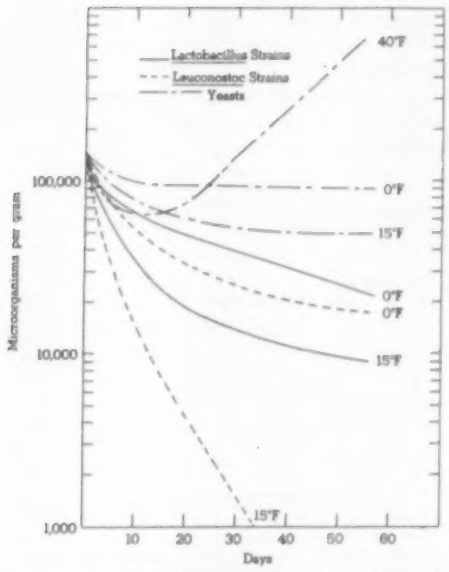


**Figure 1. Survival of microorganisms in 42° Brix concentrate stored at 0° F., 15° F., and 40° F.**

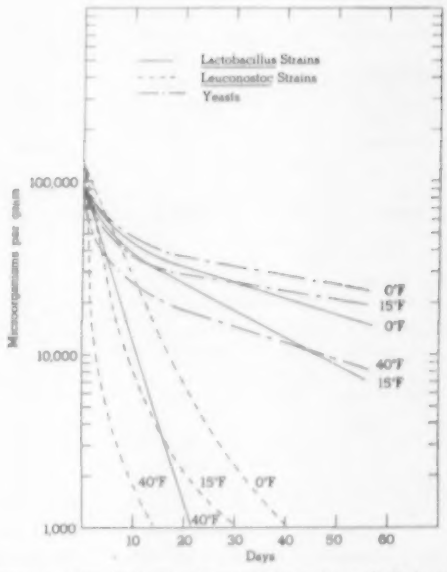


**Figure 3. Survival of microorganisms in 70° Brix concentrate stored at 0° F., 15° F., and 40° F.**

organisms present in concentrated orange juices, the yeasts predominated at 0° F. (17.8° C.) after 198 days.

It is apparent from the data that, in general, the rate of death increases as the temperature (0° to 40° F.) and the concentration (42° to 70° Brix) increase. The only exception to this was the yeasts in the 42° and 58.5° Brix concentrate which grew at 40° F. but died at 0° F. and died even more rapidly at 15° F. Growth of yeasts in 42° Brix concentrate at 40° F. occurred after 14 days and in 58.5° Brix concentrate after 18 days. No growth was noted in 70° Brix concentrate after 58 days.

The greatest rate of death of the bacteria studied occurred at 40° F. in 70° Brix concentrate. The *Leuconostoc* strains, which were the least tolerant of the concentration levels investigated, were reduced in numbers in 70° Brix concentrate from 120,000 per gram to less than 1,000 per g. in 20 days. Rushing *et al. (9)* observed that at 35° F. the microflora died faster in 70° Brix concentrate than they did in 40° Brix.

The remainder of this study dealt with the survival and/or growth rate of the test organisms in 12, 20, 30, 42, 58.5 and 70° Brix orange juices at the incubation temperature of 75° F. The effect of concentration on the growth of strains of *Leuconostoc*, *Lactobacillus* and yeasts is presented in Figures 4, 5, and 6, respectively. A tabulation of the data prepared from the growth curves is presented in Table 1. It is interesting to note that in those cases where growth occurred, the lag phase of the curves apparently increased as the concentration increased. This was particularly evident with the *Leuconostoc* and *Lactobacillus* strains investigated. The latter group of organisms showed the greatest microbial activity of the test organisms, increasing during their growth phase in 20 and 30° Brix concentrate over 100-

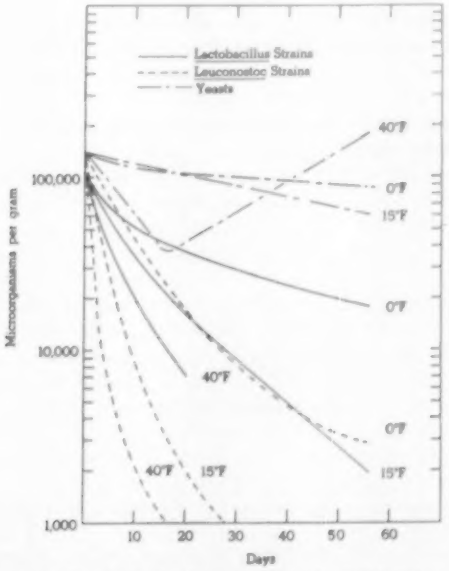


**Figure 2. Survival of microorganisms in 58.5° Brix concentrate stored at 0° F., 15° F., and 40° F.**

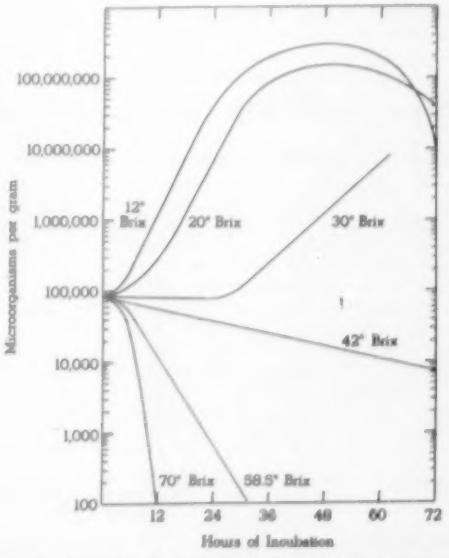


**Figure 4. Growth of Leuconostoc strains in orange concentrate of various degrees Brix at 75° F.**

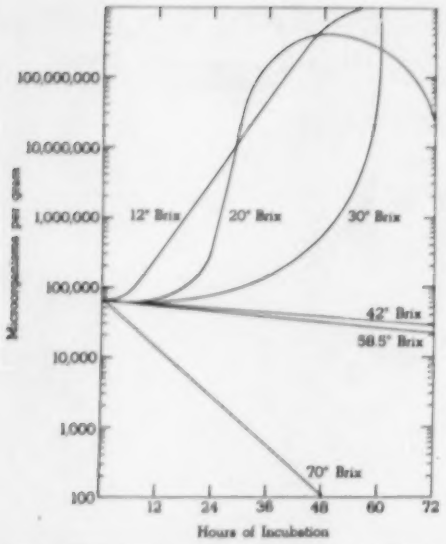


**Figure 5. Growth of Lactobacillus strains in orange concentrate of various degrees Brix at 75° F.**

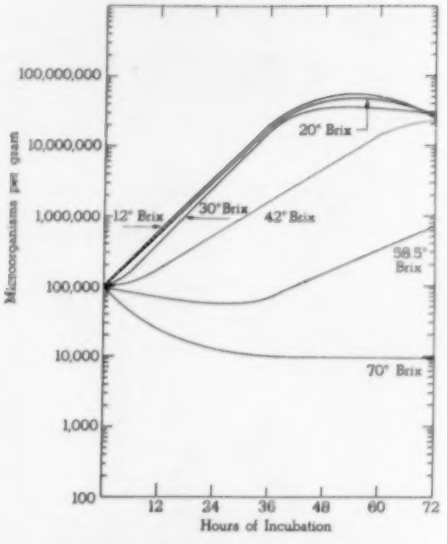


**Figure 6. Growth of osmophilic yeasts in orange concentrate of various degrees Brix at 75° F.**

fold in 12 hours. This compares to an approximately 50-fold increase for the *Leuconostoc* strains with their greatest growth activity apparently occurring in the 12 to 20° Brix range. On the other hand, the yeasts grew slower than the bacteria. Their rate of growth between 12 and 30° Brix was more or less the same, with less than a 10-fold increase during any 12-hour period of growth. In 42 and 58.5° Brix concentrate it was slightly less, and in 70° Brix concentrate the yeasts did not grow.

The bacteria died rapidly in 70° Brix concentrate with the *Leuconostoc* dying more rapidly than the *Lactobacilli*. Both genera grew well in 30° Brix, but showed an apparent reduction in numbers in 42° Brix concentrate after 72 hours of incubation at 75° F. O'brien *(6)* studied the growth of *Lactobacillus brevis*, *L. plantarum*, and *Leuconostoc mesenteroides* in concentrates of 12 to 55° Brix. He reported that these organisms grew rapidly after 48 hours of incubation at 98.6° F. (37° C.) in 12° and 18° Brix, but there was no evidence of growth in 35°, 42°, or 55° Brix concentrates. In that study, after 5 days of incubation there was some evidence of growth in 42° Brix but none in 55° Brix concentrate. It is apparent from the data that the greatest growth activity of *Leuconostoc* and *Lactobacillus* strains occurs at concentrations below 42° Brix. This is of particular interest as certain organisms of these two genera have produced off-odors and off-flavors in commercially produced concentrate [Murdock *et al. (5)*]. Assuming those organisms had growth characteristics similar to the ones studied here, one could reason that spoilage must have occurred in the juice prior to its entering the evaporators or in the lower stages of concentration.

It is evident from these studies that both temperature and degree of concentration play an important role in the growth and/or survival of the off-flavor producing microflora, normally present during processing of concentrated orange juice.

## SUMMARY

The survival of selected strains of *Leuconostoc*, *Lactobacillus* and yeast in 42°, 58.5° and 70° Brix concentrated orange juice stored at 0°, 15° and 40° F. was investigated. The death rates of the organisms appeared to increase with the temperature and with the concen-

**TABLE 1**

**Survival of strains of Leuconostoc, Lactobacillus and Yeast in 42°, 58.5° and 70° Brix concentrate at 0°, 15° and 40° F. (Microorganisms per gram)**

| Days | 0° F. | | | 15° F. | | | 40° F. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 42° | 58.5° | 70° | 42° | 58.5° | 70° | 42° | 58.5° | 70° |
| Leuconostocs: | | | | | | | | | |
| 0 | 150 | 140 | 110 | 150 | 140 | 120 | ..... | 140 | 120 |
| 10 | 52 | 44 | 27 | 15 | 8.6 | 8 | ..... | 2.2 | 1.8 |
| 20 | 33 | 17 | 7 | 4.4 | 2 | 2.1 | ..... | <1 | <1 |
| 30 | 25 | 8 | 2.3 | 1.5 | <1 | 1 | ..... | ..... | ..... |
| 40 | 21 | 4.8 | 1 | <1 | ..... | <1 | ..... | ..... | ..... |
| 50 | 18 | 3.3 | <1 | ..... | ..... | ..... | ..... | ..... | ..... |
| Lactobacilli: | | | | | | | | | |
| 0 | 115 | 140 | 100 | 115 | 140 | 100 | ..... | 140 | 100 |
| 10 | 66 | 52 | 44 | 35 | 35 | 38 | ..... | 20 | 11 |
| 20 | 49 | 38 | 32 | 19 | 16 | 25 | ..... | 7 | 1.3 |
| 30 | 39 | 28 | 26 | 14 | 8.6 | 18 | ..... | <1 | <1 |
| 40 | 31 | 24 | 21 | 11 | 4.8 | 12 | ..... | ..... | ..... |
| 50 | 25 | 20 | 17 | 9.6 | 2.7 | 8.6 | ..... | ..... | ..... |
| Yeasts: | | | | | | | | | |
| 0 | 150 | 140 | 100 | 150 | 140 | 100 | 150 | 140 | 100 |
| 10 | 98 | 115 | 48 | 76 | 120 | 37 | 65 | 60 | 25 |
| 20 | 96 | 105 | 37 | 60 | 105 | 29 | 76 | 42 | 18 |
| 30 | 94 | 100 | 33 | 54 | 90 | 26 | 140 | 64 | 15 |
| 40 | 92 | 95 | 28 | 52 | 78 | 23 | 260 | 95 | 12 |
| 50 | 90 | 90 | 25 | 50 | 66 | 21 | 480 | 140 | 9.4 |

NOTE: All counts have been divided by 1,000.

tration. The only exception to this was the yeasts in 42° Brix which grew at 40° F. but died at 0° F. and died even more rapidly at 15° F.

The growth of these microorganisms in 12, 20, 30, 42, 58.5 and 70° Brix concentrate at 75° F. was also investigated. Bacterial growth occurred in all concentrations through 30° Brix while yeasts grew in concentrations through 58.5° Brix. In 70° Brix concentrate all strains died, the *Leuconostoc* dying more rapidly than the other test organisms. In those concentrations where growth occurred, a shorter incubation period was required for microbial growth at the lower than at the higher concentrations.

**Acknowledgment**

The authors wish to thank Dr. W. R. Roy and Mr. C. H. Brokaw for their encouragement and advice and also Messrs. J. L. Froscher, W. E. Allen, T. H. Shang and M. A. Jimenez, who assisted so capably in performing the analyses.

LITERATURE CITED

1. Continental Can Co. The problem of swells in orange juice concentrate. *Food Packer*, **26**, 32 (1945).
2. Faville, L. W., Hill, E. C., and Parish, E. C. Survival of microorganisms in concentrated orange juice. *Food Technol.*, **5**, 33 (1951).
3. Hays, G. L. The isolation, cultivation and identification of organisms which have caused spoilage in frozen concentrated orange juice. *Proc. Fla. State Hort. Soc.*, 135 (1951).
4. Hays, G. L., and Riester, D. W. The control of "off-odor" spoilage in frozen concentrated orange juice. *Food Technol.*, **6**, 386 (1952).
5. Murdock, D. I., Troy, V. S., and Folinazzo, J. F. Development of off-flavor in 20° Brix orange concentrate inoculated with certain strains of Lactobacilli and Leuconostoc. *Food Technol.*, **6**, 127 (1952).
6. O'Brien, D. J. American Can Company, Tampa, Florida. (Personal communication, 1954).
7. Patrick, R. The role of micro-organisms and storage temperatures on the quality of orange concentrates. *Citrus Industry*, **31** (8), 13 (1950).
8. Recca, J., and Mrak, E. M. Yeasts occurring in citrus products. *Food Technol.*, **6**, 450 (1952).
9. Rushing, N. B., Patrick, R., and Veldhuis, M. K. Effect of concentration of orange juice and temperature of storage on growth and survival of microorganisms. *Proc. Fla. State Hort. Soc.*, 281 (1953).

# Detection of Washed Eggs with Ultraviolet Light

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(Manuscript received July 20, 1954)

**The use of ultraviolet radiation as a means of detecting washed eggs, a source of serious spoilage in shell eggs produced for the market, is described. The method is effective in detecting washed eggs, the percentage of accuracy ranging from 80% to 100%.**

This study is a further contribution to the series designed to develop reliable tests for washed eggs. As indicated earlier by Hixon, Connolly and Stewart *(1)*, the problem of serious spoilage in shell eggs which have been washed is still with the industry. A reliable and rapid test for washed eggs would permit egg handlers to identify such eggs and to take appropriate measures to assure their elimination from channels of trade.

Previous studies using the conductivity of shell extracts have been reported by Hixon, Connolly and Stewart *(1, 2)*. Although the conductivity test is reasonably acurate and rapid, it leaves much to be desired as a practical quality control measure. Accordingly, it was decided to explore other, more simple means for detecting the washed egg. This paper reports studies wherein the change in appearance of the shell under ultraviolet radiation was used as a criterion. The origin of the suggestion that this scheme might work is not definitely known. However, we wish to credit Dr. F. W. Lorenz of the University of California Poultry Husbandry Department for calling it to our attention.

## EXPERIMENTAL

Practically all of our studies have been conducted with a Keese[b] Model No. 160E I-2 portable ultraviolet flood light unit equipped with a 100-watt G. E. H100-F1-4 lamp and a dark blue Corex filter. Wave length or intensity of the ultraviolet radiation was not studied in relation to the accuracy of detection but, for the purpose of this experiment, the shell eggs were examined under the radiation from the above source in a darkened room.

The shells of unwashed eggs appear blue to red violet under ultraviolet radiation, and this is sharply contrasted with the greenish fluorescence of any fecal matter adhering to the shell. The primary difference in the appearance of washed eggs as compared to unwashed is the "smearing" of areas where the fecal matter was originally present. Other differences, which appear less frequently, are greyish white water spots, a brilliant blue fluorescence of any residual detergent used, and a light blue fluorescent line left by cloth rollers.

It might seem that these rather vague differentiations would not permit accurate detection. However, experience has proved otherwise. After a little experience and practice, operators show no hesitation in classifying eggs washed or unwashed even though a precise description of the difference cannot be given. It should be stated that detection accuracy is dependent on carrying out the test on groups of eggs rather than on individual eggs. In practice this means groups of a dozen, thirty, or thirty-six eggs at a time—the units in common use in egg handling plants. In the studies reported here we used as a unit a flat of thirty eggs with the eggs placed large end up in a Keyes fillerflat.

Initial trials were made using eggs from the University flock. Washing was accomplished by hand. Later, two field tests were

[a] Employed jointly by Biological Sciences Branch, Agricultural Marketing Service, and University of California. This work was financed under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

[b] The name of this firm is given for the convenience of other workers but with the understanding that the U. S. Dept. of Agriculture does not endorse the product of one company over those of other companies.

run. Here a variety of washing conditions were encountered. In addition, a wide variation in egg source and handling procedures was encountered. In the trials 6 fillerflats of both washed and unwashed eggs were obtained from each of 15 ranches in an area where washing is quite common (Sonoma County). Methods of cleaning on these ranches are the same as reported earlier *(2)*.

In the area from which the sample was drawn, all eggs (not just dirties) are washed. We know that this practice does not prevail for California as a whole or for the country at large, for that matter. Accordingly, field trials were set up, using varying incidences of washed and unwashed eggs.

## RESULTS AND DISCUSSION

In preliminary trials it was noted that washed eggs could be detected readily and rapidly, with accuracies running as high as 100% on an individual egg basis. However, it was also observed that washing with abrasives and drying so as to eliminate water spotting made it much more difficult to detect the washed egg. Strangely enough, carefully cleaned eggs which were originally badly soiled were sometimes the most difficult to detect, due possibly to the removal of all fecal material.

All in all, the preliminary tests were encouraging. Detection accuracies for all types of eggs (naturally clean and dirty) and for a variety of washing techniques averaged approximately 85%.

The results of the first field test are given in Table 1. It will be noted that the 30% incidence level was run in duplicate. The order of presentation to the operator was assigned from a table of random numbers. It so happened that the two 30% levels were the first presented. This may account for the relatively high Type "1" error in both of these two incidences.

It is clear that error in detecting washed (Type "1") eggs was exceedingly low; that for unwashed eggs (Type "2" error) reasonably good. The errors were not appreciably affected by varying incidence levels.

Table 2 shows the detection error for eggs from different ranches. It would appear that there are real differences among ranches, although the number of flats missed even in the worst case is too small to be statistically significant.

Variation in detection errors did not seem to be related to type of washing, although actually there was not a great deal of difference in most of the equipment and methods used.

**TABLE 2**

**Errors in detecting washed eggs by use of ultra-violet light—effect of source of eggs**

| Ranch No. | Type of washing | No. flats observed | No. missed | % Error |
|---|---|---|---|---|
| 1 | II-c | 25 | 0 | 0 |
| 2 | I-f | 25 | 2 | 8.0 |
| 3 | I-g | 25 | 1 | 4.0 |
| 4 | II-a | 25 | 0 | 0 |
| 5 | I-e | 24 | 0 | 0 |
| 6 | I-c | 24 | 0 | 0 |
| 7 | I-a | 24 | 0 | 0 |
| 8 | I | 25 | 0 | 0 |
| 9 | III | 24 | 0 | 0 |
| 10 | II-d | 24 | 2 | 8.2 |
| 11 | I-b | 25 | 4 | 16.0 |
| 12 | I | 25 | 5 | 20.0 |
| 13 | II-b | 25 | 0 | 0 |
| 14 | I-e | 24 | 0 | 0 |
| 15 | II | 25 | 3 | 12.0 |
| Totals and Ave. | | 369 | 17 | 4.6 |

The second field trial was similar in most respects (including sampling and ranches involved). One change in detection procedure was made. In this trial the operator had at his disposal eggs known to be washed or unwashed. He was permitted to refresh his memory of differences by examining these "knowns" before the test.

**TABLE 1**

**Effect of incidence on errors in detecting washed eggs**

| Run No. | Incidence of washed eggs % | Washed | | | *Unwashed* | | |
|---|---|---|---|---|---|---|---|
| | | No. of flats | No. of missed | % Type [1] "1" error | No. of flats | No. of missed | % Type [2] "2" error |
| VI | 0 | 0 | .... | .... | 90 | 12 | 13.3 |
| IX | 10 | 9 | 0 | 0.0 | 81 | 10 | 12.3 |
| III | 26 | 18 | 0 | 0.0 | 72 | 18 | 25.0 |
| I | 30 | 27 | 8 | 29.6 | 63 | 2 | 3.3 |
| II | 30 | 27 | 3 | 11.1 | 63 | 8 | 12.7 |
| VIII | 50 | 45 | 0 | 0.0 | 45 | 12 | 26.7 |
| VII | 80 | 72 | 2 | 2.8 | 18 | 3 | 16.7 |
| V | 90 | 81 | 1 | 1.2 | 9 | 2 | 22.2 |
| IV | 100 | 90 | 3 | 3.3 | 0 | .... | .... |
| Totals and Ave. | | 369 | 17 | 4.6 | 441 | 67 | 15.2 |

[1] Type "1" error—calling washed egg unwashed.
[2] Type "2" error—calling unwashed egg washed.

**TABLE 3**

**Errors in detecting washed eggs at varying incidence levels (Trial II)**

| Test No. | Incidence of washing % | Washed | | | Unwashed | | |
|---|---|---|---|---|---|---|---|
| | | No. flats occurring | No. flats missed | % Type "1" error | No. flats occurring | No. flats missed | % Type "2" error |
| 1 | 20 | 18 | 1 | 5.5 | 72 | 4 | 5.6 |
| 2 | 100 | 90 | 1 | 1.1 | 0 | .... | .... |
| 3 | 50 | 45 | 4 | 8.8 | 45 | 2 | 4.4 |
| 4 | 30 | 27 | 1 | 3.7 | 63 | 5 | 8.0 |
| 5 | 0 | 0 | .... | .... | 90 | 0 | 0 |
| 6 | 80 | 72 | 2 | 2.8 | 18 | 1 | 5.5 |
| 7 | 90 | 81 | 5 | 6.2 | 9 | 2 | 22.2 |
| 8 | 10 | 9 | 1 | 11.1 | 81 | 4 | 4.9 |
| Totals and Ave. | | 342 | 15 | 4.4 | 378 | 18 | 4.7 |

**TABLE 4a**

**Errors in detecting washed eggs as influenced by source [1]**

| Ranch No. | Type of wash | Test I | | | Test II | | | Combined | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. flats observed | No. missed | % Error | No. flats observed | No. missed | % Error | No. flats observed | No. missed | % Error |
| 1 | II-e | 25 | 0 | 0 | 22 | 1 | 4.5 | 47 | 1 | 2.1 |
| 2 | I-f | 25 | 2 | 8.0 | 23 | 2 | 8.7 | 48 | 4 | 8.3 |
| 4 | II-a | 25 | 0 | 0 | 23 | 3 | 13.0 | 48 | 3 | 6.5 |
| 5 | I-e | 24 | 0 | 0 | 23 | 0 | 0 | 47 | 0 | 0 |
| 6 | I-e | 24 | 0 | 0 | 23 | 0 | 0 | 47 | 0 | 0 |
| 7 | I-a | 24 | 0 | 0 | 23 | 0 | 0 | 47 | 0 | 0 |
| 8 | I | 25 | 0 | 0 | 23 | 1 | 4.4 | 48 | 1 | 2.1 |
| 9 | III | 24 | 0 | 0 | 22 | 0 | 0 | 46 | 0 | 0 |
| 10 | II-d | 24 | 2 | 8.3 | 23 | 1 | 4.4 | 47 | 3 | 6.4 |
| 11 | I-b | 25 | 4 | 16.0 | 23 | 1 | 4.4 | 48 | 5 | 10.4 |
| 12 | I | 25 | 5 | 20.0 | 23 | 2 | 8.7 | 48 | 7 | 14.6 |
| 13 | II-b | 25 | 0 | 0 | 22 | 0 | 0 | 47 | 0 | 0 |
| 14 | I-c | 24 | 0 | 0 | 23 | 0 | 0 | 47 | 0 | 0 |
| 15 | II | 25 | 3 | 12.0 | 23 | 3 | 13.0 | 48 | 6 | 14.0 |
| Totals and Ave. | | 269 | 17 | 4.6 | 342 | 15 | 4.4 | 711 | 32 | 4.5 |

[1] Ranch 3 modified its washing procedure between reports, making comparison invalid.

**TABLE 4b**

**Errors in detecting unwashed eggs as influenced by source**

| Ranch No. | Test I | | | Test II | | | Combined | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. observed | No. missed | % Error | No. observed | No. missed | % Error | No. observed | No. missed | % Error |
| 1 | 29 | 3 | 10.3 | 26 | 0 | 0 | 55 | 3 | 5.4 |
| 2 | 29 | 3 | 10.3 | 25 | 1 | 4.0 | 54 | 4 | 7.4 |
| 3 | 29 | 1 | 3.5 | 25 | 1 | 4.0 | 54 | 2 | 3.7 |
| 4 | 29 | 4 | 13.4 | 25 | 2 | 8.0 | 54 | 6 | 11.1 |
| 5 | 30 | 2 | 6.7 | 26 | 4 | 15.4 | 56 | 6 | 10.7 |
| 6 | 30 | 0 | 0 | 25 | 1 | 4.0 | 55 | 1 | 1.8 |
| 7 | 30 | 19 | 63.3 | 25 | 8 | 32.0 | 55 | 27 | 49.1 |
| 8 | 29 | 2 | 6.9 | 25 | 0 | 0 | 54 | 2 | 3.7 |
| 9 | 30 | 10 | 33.3 | 26 | 0 | 0 | 56 | 10 | 17.9 |
| 10 | 30 | 1 | 3.3 | 25 | 0 | 0 | 55 | 1 | 1.8 |
| 11 | 29 | 1 | 3.5 | 25 | 1 | 4.0 | 54 | 2 | 3.7 |
| 12 | 29 | 3 | 10.3 | 25 | 0 | 0 | 54 | 3 | 5.6 |
| 13 | 29 | 11 | 37.9 | 25 | 0 | 0 | 54 | 11 | 20.4 |
| 14 | 30 | 1 | 3.3 | 25 | 0 | 0 | 55 | 1 | 1.8 |
| 15 | 29 | 6 | 20.7 | 25 | 0 | 0 | 54 | 6 | 11.1 |
| | 441 | 67 | 15.2 | 378 | 18 | 4.9 | 819 | 85 | 10.4 |

Table 3 shows the results of the second field trial. The Type "1" error again was very low. The Type "2" error was also very low and compared favorably with Type "1" error. We attribute this improvement to greater experience and the use of the known controls for ready reference to the operators.

Tables 4a and 4b show a comparison of detection accuracy from the two trials with respect to origin of eggs. While there is considerable variation in the number of washed eggs missed, it is so small in any one case as to make difficult a conclusion that ranch factors affect detection accuracy. On the other hand, the high percentage of Type "2" errors from ranch 7 indicates that some subtle difference in management may make detection difficult. Detailed survey of practices on this ranch did not reveal any clues as to the cause of the high number of errors.

## SUMMARY

A method of detecting washed eggs by examination under ultraviolet radiation has been investigated. Two field trials using this method have been conducted. It would appear that accuracies of 80-100% can be achieved using this method.

## LITERATURE CITED

1. Hixon, Raymond, Connolly, R. J., and Stewart, George F. Detection of washed eggs by conductivity measurements. I. Test methodology. *Food Research*, **19**, 1 (1954).
2. Hixon, R. R., and Stewart, G. F. Detection of washed eggs by conductivity measurements. II. Field testing. *Food Technol.*, 8, 422 (1954).

# Properties of Stored Frozen Orange Concentrate Observed by Differential Cloud Determination[a]

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(Manuscript received June 25, 1954)

**Differential cloud values are determined in a given sample of frozen orange concentrate immediately after thawing and again after holding at 40° F. for over 24 hours. This differential cloud determination has been applied over the past two and a half years to five lots of commercial frozen orange concentrate stored under constant and fluctuating temperature conditions. The results indicate that low cloud values observed immediately after thawing reflect previous exposure to elevated temperatures. Low cloud values observed after holding the sample for 24 hours at 40° F. reflect "sensitization" of concentrate to cloud loss which follows prolonged storage even at temperatures below 0° F.**

The natural orange-colored turbidity in reconstituted frozen orange concentrate is commonly referred to as "cloud." When concentrate is exposed to elevated temperatures such as 40° F. (4° C.), enzyme-catalyzed changes are believed to occur in various constituents which are reflected in poor cloud stability *(2, 3, 6, 8, 9, 10)*. On reconstitution of such thawed concentrates the finely divided particles settle, leaving a clear supernatant serum. This effect, known as "cloud loss," markedly reduces the acceptability of frozen orange concentrates.

Studies on the storage stability of commercially frozen orange concentrates have been under way for the past three years in this Laboratory. Five lots have been subjected to schedules of constant and varied temperatures. The differential measurement of cloud during these studies revealed that some types of concentrate acquire, during storage, an increasing sensitivity to loss of cloud when exposed to elevated temperatures. By means of this test it was also possible to distinguish between the acquired sensitivity to cloud loss, and cloud loss that had resulted from prior thawing. The differential cloud test also appeared useful in estimating the inherent cloud stability of concentrate at the time of manufacture, and in evaluating the amount of sensitivity to cloud loss on thawing, which had accrued at any time during storage.

## EXPERIMENTAL PROCEDURE

**Time-temperature patterns.** The 5 lots of commercial concentrate were stored for 12 months at 0° F. (—17.8° C.). After the first month of storage, samples from each lot were withdrawn and exposed to a pattern of thawing temperatures according to the schedule shown in Figure 1. After this temperature excursion, these samples were returned to 0° F. storage. For use in a later figure (Figure 3) these samples have been given codes based upon the highest temperature to which they were exposed during the 12-month period. The code consists of a number, 0, 20, or 40, representing the maximum temperature reached.

**Differential cloud determination.** Processors and brokers have determined cloud in frozen orange concentrates by one of two different procedures. One procedure consists simply of a determination of cloud on the sample as soon as it is thawed and reconstituted. The other procedure, often employed, consists of holding the concentrate at 40° F. for a period before reconstituting and determining cloud. This latter practice is based on the belief that such a determination will more accurately reflect the condition of cloud at the consumer level.

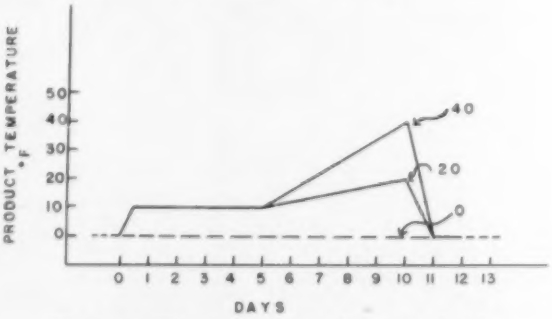


**Figure 1. Plot of thawing conditions employed.**

The differential cloud determination, herein described, consists of determining cloud on samples of concentrate by both procedures and comparing the results. An immediate cloud determination is made on a given sample of concentrate and an aliquot of the same sample is stored at 40° F. for 24 hours after which cloud is again determined. For reasons to be seen later, cloud values obtained by the first procedure will be referred to as "thawing index" (TI) and cloud values determined after holding at 40° F. will be referred to as "sensitivity index" (SI).

Aside from the differential method of sampling, the procedure used is similar to others previously described *(5, 6)*. Concentrate was thawed 15 minutes under tap water and a 25-g. sample withdrawn and diluted with 75 g. of distilled water. The remaining thawed concentrate was placed in storage at 40° F. for the subsequent SI determination. The diluted sample was held for one hour at 86° F. (30° C.); then 30 ml. was placed in a 50-ml. centrifuge tube and centrifuged for 15 minutes at 2,000 r.p.m. in a clinical centrifuge (radius of the head was 5.5 inches from the shaft to the far tip of the test-tube carrier). After centrifuging, the resulting supernatant was withdrawn and its light transmission measured with a Klett[d] Colorimeter employing a No. 66 filter. Cloud readings were expressed as the numerical values of optical density on the Klett transmission scale readings.

Determinations of TI and SI were made on all lots of concentrate immediately after their production and at 1-, 3-, 6-, and 12-month intervals during the 0° F. storage (Figure 2). TI and SI determinations were made on the samples exposed to the

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[d] The mention of special instruments or materials throughout this paper does not imply that they are endorsed or recommended by the Department of Agriculture over others of a similar nature not mentioned.

thawing conditions of Figure 1 immediately after the product temperatures had returned to 0° F. (Figure 3).

**The centrifuge as a variable.** Originally, speeds of the clinical centrifuges employed in cloud determinations were calibrated by a series of successive approximations. In this process the centrifuge, under normal load of sample and with cover closed, was allowed to reach constant speed and then the cover was opened and the speed read as quickly as possible from a tachometer applied to the rotating shaft. Checking and readjustment of speed were continued until an "instantaneous" tachometer reading of 2,000 r.p.m. was obtained. This process was adopted since it was obvious that the speed of the centrifuge dropped markedly when the tachometer was applied or even when the centrifuge cover was opened to make the measurements.

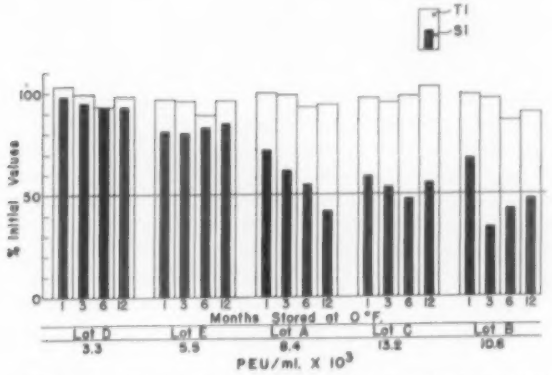


**Figure 2. Changes in percent of initial thawing index (TI) and storage index (SI) cloud values during storage at 0° F.**

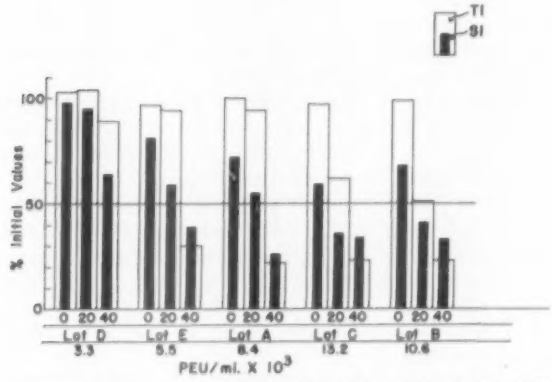


**Figure 3. Changes in percent of initial thawing index (TI) and storage index (SI) cloud values following the thawing conditions (coded 0, 20, and 40) of Figure 1.**

Later, transparent plastic windows were inserted in the centrifuge covers and the speeds easily and accurately calibrated under operating conditions by viewing the rotating head with a frequency-calibrated stroboscopic light. With the accurate determinations of speed made possible by this system, a brief survey was made of the variability of the centrifuge speeds under some of the previous operating conditions. Since most centrifuges employed for cloud determinations are still calibrated with tachometers, the extreme variability found to occur under these conditions is presented in Table 1. In addition, smaller variations were found as a result of changes in room temperature from day to day, changes in the volume of sample placed in the cups, and random variations in line voltage. It is apparent that in determining cloud in citrus concentrates, great care must be taken to insure that the centrifuge speeds are accurately known.

**TABLE 1**

**Effect of some factors on speeds of clinical-type centrifuges employed in cloud determinations**

| Operating conditions [1] | Speed determined by Strobe light | Incremental % increase in r.p.m. | Resulting cloud values [2] | | |
|---|---|---|---|---|---|
| | | | Sample 1 | Sample 2 | Sample 3 |
| | *r.p.m.* | | | | |
| Cover open, tachometer connected | 1,130 | — | 560 | 460 | 81 |
| Cover open, tachometer disconnected | 1,530 | 35 | 540 | 430 | 70 |
| Cover closed, head running free | 2,000 | 30 | 510 | 400 | 65 |

[1] Voltage constant.
[2] Klett readings.

## RESULTS AND DISCUSSION

Results of the application of the differential cloud test on stored frozen orange concentrates are shown in Figures 2 and 3. TI and SI cloud values are plotted as the percentages of their respective initial values determined in the freshly manufactured concentrate. The pectinesterase (PE) *(7)* contents of the different lots are also indicated. It should be noted that lot D was stabilized against cloud loss by heat treatment.

The most important result shown in Figure 2 is that, in contrast to the TI values which remain within nearly 90% of their initial values in all lots of concentrate throughout the 12 months' storage period, the SI values in the less stable lots show a 30-40% decrease after the first month of storage and thereafter tend to become as low as 50% of the initial values. This observation may be interpreted as an acquired sensitivity to cloud loss, upon subsequent exposure to higher temperatures, which builds up in unstabilized frozen concentrates after storage for a few months at 0° F.

Referring now to Figure 3, which compares TI and SI values resulting from the thawing schedules of Figure 1, it is seen that, where cloud loss results from thawing, this fact is reflected in a decrease of both the TI and the SI values. In the light of the results of Figure 2 it is apparent that a loss of cloud shown by the TI determination indicates that such loss has occurred as a result of prior thawing. In the light of Figure 3 it is apparent that SI values only indicate the extent of acquired sensitivity to cloud loss in the event that high values of TI show that no prior cloud loss due to thawing has occurred. When low TI values indicate cloud loss resulting from prior thawing, SI values must be considered indeterminant.

It appears from Figures 2 and 3 that frozen orange concentrates may possess 2 distinct kinds of cloud instability. One type results in a loss of cloud when concentrates are exposed to thawing temperatures. The other type manifests itself as an increasing sensitivity to loss of cloud, when exposed to temperatures in excess of 20° F., which some concentrates acquire during storage at 0° F.*

* That this effect is a true sensitization and not a simple cumulation of incipient cloud loss at 0° F. is supported not only by the fact that TI values do not partake of this sensitization, but also by the fact that during storage for a year at —10° F. and even —95° F. the SI values are still observed to fall to as low as 50 to 70% of their initial values.

**TABLE 2**

**TI and SI values of frozen orange concentrate stored at 0° F.**

| Lot | Months stored | PEu/ml. x $10^9$ | TI [1] | SI [1] | TI x SI x $10^{-3}$ | SI/TI | % Change in SI/TI during first month |
|---|---|---|---|---|---|---|---|
| D | 0 | 3.3 | 377 | 365 | 138 | 0.97 | 5 |
| D | 1 | .... | 390 | 357 | 139 | 0.92 | |
| D | 3 | .... | 375 | 345 | 129 | 0.92 | |
| D | 6 | .... | 350 | 340 | 119 | 0.97 | |
| D | 12 | .... | 370 | 340 | 125 | 0.92 | |
| E | 0 | 5.5 | 450 | 230 | 104 | 0.51 | 16 |
| E | 1 | .... | 435 | 187 | 81 | 0.43 | |
| E | 3 | .... | 430 | 185 | 79 | 0.43 | |
| E | 6 | .... | 400 | 190 | 76 | 0.48 | |
| E | 12 | .... | 435 | 195 | 86 | 0.45 | |
| A | 0 | 8.4 | 398 | 242 | 96 | 0.61 | 28 |
| A | 1 | .... | 398 | 174 | 69 | 0.44 | |
| A | 3 | .... | 395 | 150 | 59 | 0.38 | |
| A | 6 | .... | 370 | 134 | 49 | 0.36 | |
| A | 12 | .... | 375 | 102 | 38 | 0.27 | |
| C | 0 | 13.2 | 380 | 175 | 66 | 0.56 | 32 |
| C | 1 | .... | 370 | 104 | 38 | 0.38 | |
| C | 3 | .... | 362 | 95 | 34 | 0.19 | |
| C | 6 | .... | 374 | 84 | 31 | 0.27 | |
| C | 12 | .... | 390 | 98 | 38 | 0.29 | |
| B | 0 | 10.6 | 360 | 200 | 72 | 0.46 | 36 |
| B | 1 | .... | 355 | 135 | 48 | 0.28 | |
| B | 3 | .... | 349 | 68 | 24 | 0.26 | |
| B | 6 | .... | 310 | 85 | 26 | 0.22 | |
| B | 12 | .... | 325 | 95 | 31 | 0.25 | |

[1] Klett readings.

Figures 2 and 3 have presented TI and SI cloud data in terms of percentages of initial values in order to aid in the comparison of the various lots, all having different absolute values of TI and SI. Initial values are not ordinarily available to everyone who may be concerned with estimating the inherent stability of different lots of concentrate at any given time. It is therefore desirable to see whether the absolute cloud values obtained at any time might be employed to detect acquired sensitivity to cloud loss, and to distinguish between acquired sensitivity and actual cloud loss which has resulted from prior thawing.

Tables 2 and 3 present the actual cloud data from which Figures 2 and 3, respectively, were derived, as well as the products of TI and SI and the ratios of SI to TI. Considering the ratio SI/TI in Table 2, it is apparent that the acquired sensitivity, during storage, to cloud loss on thawing is well indicated by the change in these ratios for lots A, C, and B with time. In the 4 lots of unheated concentrate this ratio has a value for freshly prepared material in the range 0.5 to 0.6, and is seen to decrease subsequently in proportion to the extent that the different lots acquire sensitivity to cloud loss as illustrated in Figure 2. It is interesting to note that in the heat-treated lot D the ratio has a value of an entirely different order of magnitude (0.97).

**TABLE 3**

**TI and SI values of frozen orange concentrate exposed to thawing conditions of Figure 1**

| Lot | Thawing condition | TI [1] | SI [1] | TI x SI x $10^{-3}$ | SI/TI |
|---|---|---|---|---|---|
| D | 0 | 390 | 357 | 139 | 0.91 |
| D | 20 | 395 | 345 | 136 | 0.87 |
| D | 40 | 335 | 234 | 78 | 0.70 |
| E | 0 | 435 | 187 | 81 | 0.43 |
| E | 20 | 425 | 135 | 57 | 0.32 |
| E | 40 | 135 | 90 | 12 | 0.66 |
| A | 0 | 398 | 174 | 69 | 0.44 |
| A | 20 | 373 | 132 | 49 | 0.35 |
| A | 40 | 86 | 62 | 5 | 0.72 |
| C | 0 | 370 | 104 | 38 | 0.28 |
| C | 20 | 236 | 62 | 15 | 0.27 |
| C | 40 | 89 | 59 | 5 | 0.66 |
| B | 0 | 355 | 135 | 48 | 0.38 |
| B | 20 | 182 | 82 | 15 | 0.45 |
| B | 40 | 82 | 65 | 5 | 0.79 |

[1] Klett readings.

Although lots E and A differ in acquiring sensitivity to cloud loss during storage, both lots show about the same sensitivity to thawing after the first month's storage as indicated by the respective ratios 0.43 and 0.44. This is in good agreement with the results of Figure 3 which show that, at this time, both lots of concentrate undergo cloud loss to practically the same extent under the thawing conditions of Figure 1. Later, when lot A has acquired sensitivity as indicated by the changing ratio, it undergoes greater cloud loss under thawing stress than does Lot E.

In considering the products of TI x SI x $10^{-3}$ in Table 2 it is seen that at zero time these values fall into 3 categories which are separated by a large order of magnitude. Thus the initial products for lots B and C are 72 and 66, respectively, and differ by a value of 6 from each other. The initial products for lots A and E differ from each other by 8 but differ from lots B and C by not less than 24. The initial product for lot D in turn differs from that for A or E by not less than 34. When these values are compared with the results of Figure 3, the suggestion is apparent that the products TI x SI in freshly prepared concentrate may prove an accurate indicator of the cloud stability of the product at that time.

Although the initial products of TI x SI in Table 2 appear to reflect the inherent cloud stability of frozen concentrate at the time of manufacture, this estimate is subject to the shortcoming already discussed that not all

concentrates retain their initial cloud stability throughout their storage life. It would therefore be desirable to seek a value which would reflect not only the inherent stability of freshly prepared concentrate, but would also tend to incorporate the tendency of the concentrate to become less stable during storage. Since a large proportion of the sensitization appears in the first month of storage, a comparison of the change in TI and SI values during this period might be expected to reflect overall stability. The product of TI x SI, is not suitable, since TI does not share in the sensitization effect. It is seen in Table 2, however, that the values for changes in the ratio SI/TI during the first month of storage are in excellent agreement with the overall stability of all lots of concentrate, the lots suffering the greatest change having the least overall stability.

In Table 3 it is seen that TI x SI approach values of still another order of magnitude when an objectionable amount of cloud loss has occurred as a result of prior thawing. These values lie in the range 5 to 15 x $10^{-3}$ in those samples where the amount of cloud loss resulting from thawing might become objectionable to a consumer. Table 3 also illustrates the importance of determining cloud differentially and interpreting one result in the light of the other, for in samples where cloud loss has resulted from thawing, the ratio SI/TI approaches 1 and cannot be used as an indication of acquired sensitivity.

## CONCLUSIONS

Results indicate that some lots of frozen orange concentrate tend, during storage at 0° F., to acquire increasing but variable sensitivity to loss of cloud when exposed to temperatures in excess of 20° F. Therefore the method of determining cloud stability in freshly prepared concentrate which involves holding at 40° F. cannot be relied on to indicate the cloud stability of the product under the same conditions after a few months' storage at 0° F. By means of the differential cloud determination it is possible to estimate the extent of acquired sensitivity to cloud loss and to distinguish it from cloud loss resulting from prior thawing. A determination of the sensitization of concentrates should prove useful in selecting relatively stable concentrates for distribution in channels where maintenance of 0° F. is not assured, and reserving concentrates which have become sensitive to cloud loss as a result of storage for distribution to nearby locations or in channels where thawing temperatures are rarely encountered.

So far as the limited number of lots of concentrate studied are concerned, there is an indication that the product of the "thawing index" and the "sensitivity index" may indicate the degree of inherent cloud stability achieved in concentrate at the time of manufacture. Where a period of storage can be employed, it also appears that the change in the ratio of sensitivity index to thawing index after storage for one month at 0° F. gives a good indication of the overall cloud stability which may be expected from a lot of concentrate throughout its storage life. In view of the disappointing results obtained in employing pectinesterase determinations as an index of cloud stability *(1, 4, 5)*, it is suggested that the product and the ratios of SI and TI might be investigated by the concentrate industry, as possible new tests having value in judging the stability of frozen orange concentrates.

## LITERATURE CITED


1. Bissett, O. W., Veldhuis, M. K., and Rushing, N. B. Effect of heat treatment temperature on the storage life of Valencia orange concentrates. *Food Technol.*, **7**, 258 (1953).
2. Cotton, R. H., Roy, W. R., Brokaw, C. H., McDuff, O. R., and Schroeder, A. L. Storage studies on frozen citrus concentrates. *Proc. Florida State Hort. Soc.*, **60**, 39 (1947).
3. DuBois, C. W., and Kew, T. J. Storage temperature effects on frozen citrus concentrates. *Refrig. Eng.*, **59**, 772 (1951).
4. Guyer, R. B., and Bissett, O. W. Effect of heat treatment on the cloud stability and flavor of frozen orange concentrate made from pineapple and Valencia oranges. *Third Citrus Processing Conference, Bureau of Agr. and Ind. Chem., U. S. Dept. of Agriculture*, Winter Haven, Florida, Oct. (1953).
5. Keller, G. J., Rice, R. G., McColloch, R. J., and Beavens, E. A. Stabilization of frozen citrus concentrates by heat treatment. *Food Technol.*, **8**, 195 (1954).
6. Loeffler, H. J. Processing of orange juice. *Ind. Eng. Chem.*, **33**, 1308 (1941).
7. MacDonnell, L. R., Jansen, E. F., and Lineweaver, H. The properties of orange pectinesterase. *Arch. Biochem.*, **6**, 389 (1945).
8. Rouse, A. H. Gel formation in frozen citrus concentrates thawed and stored at 40° F. *Proc. Florida State Hort. Soc., 62nd Ann. Meeting*, **62**, 170 (1949).
9. Stevens, J. W., Pritchett, D. E., and Baier, W. E. Control of enzymatic flocculation of cloud in citrus juices. *Food Technol.*, **4**, 469 (1950).
10. Wenzel, F. W., Moore, E. L., Rouse, A. H., and Atkins, C. D. Gelation and clarification in concentrated citrus juices. I. Introduction and present status. *Food Technol.*, **5**, 454 (1951).

# Transportation of Frozen Citrus Concentrates and Other Frozen Foods[a]

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(Manuscript received July 13, 1954)

U. S. Deparment of Agriculture studies on transportation of citrus concentrate were initiated in March 1950. During that year 11 rail and 23 truck tests with various types of refrigeration units and installations were made. The general results and conclusions of these tests were reported to this Institute[b] and were subsequently published *(7, 8)*. This paper is a report on transportation tests since 1951.

The demand of the industry for cars and trucks that would hold frozen citrus concentrate at zero or lower temperatures in transit suggested the desirability of carrying on extensive tests to obtain accurate information on current transport refrigeration performance for guidance in improving it where necessary. The greatest progress has been in the direction of mechanical refrigeration. Mechanical refrigeration units adapted to cars and trucks have generally proved to have adequate capacity for frozen loads. However, in trucks, the method of application of the refrigeration to the load frequently has been inefficient and the air circulation inadequate. These defiiciencies have resulted in undesirably high temperatures in the bottom and side positions. Since 1950 emphasis has been placed on improvement of truck refrigeration.

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

[b] At the Eleventh Annual Meeting of IFT, New York, N. Y., June 17-21, 1951.

## SUMMARY OF FINDINGS ON TRUCK REFRIGERATION STUDIES

**Return air ducts.** Two trailers equipped with a common type of gasoline powered refrigeration unit installed in the conventional manner (Figure 1) were compared with trailers in which the special return air ducts were installed as proposed by Department workers to improve air circulation around the load (Figure 2). These ducts drew the return air into the unit from a position just above the floor in the nose of the trailer, thereby producing a flow of air along the floor strips or racks under the load. Temperatures were lower and more uniform in the modified trailer than in the one with the regular installation. In the June 1952 tests the commodity temperature ranges at destination were −1.4° to 4.8° F. in the modified and −1.9° to 8.9° in the regular trailers. In the July test they were −1° to 3° and −7.0° to 14.0°, respectively *(1)*. Highest temperatures were at

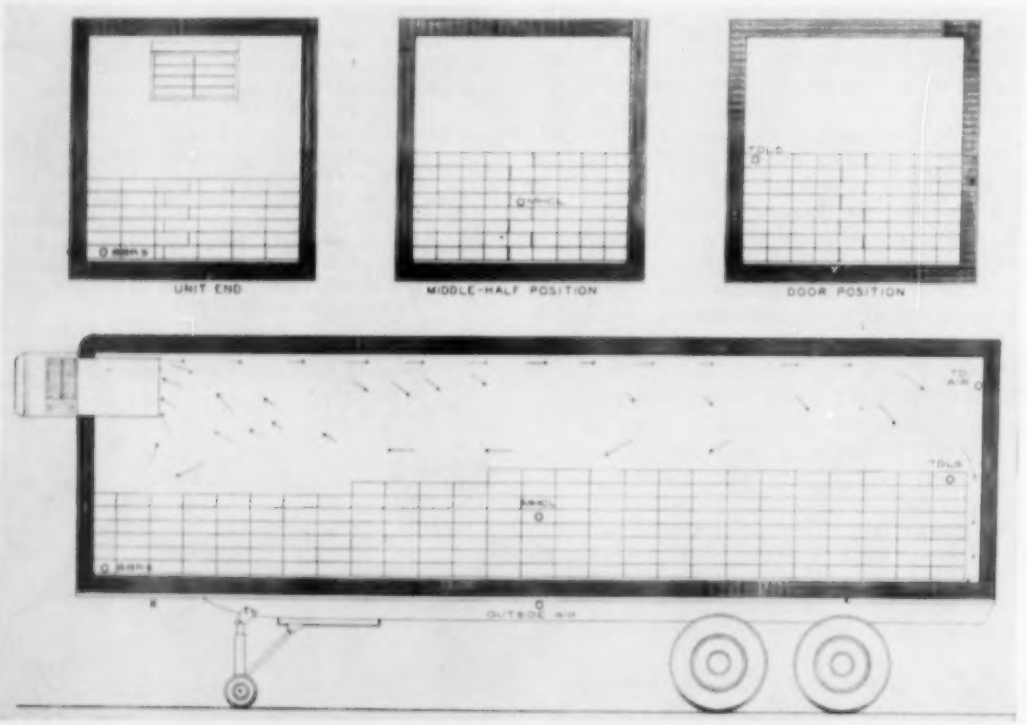


**Figure 1. Diagram of mechanically refrigerated trailer with unit mounted in nose and with normal loading pattern, showing lack of air circulation around load because of position of return air inlet immediately below discharge opening.**

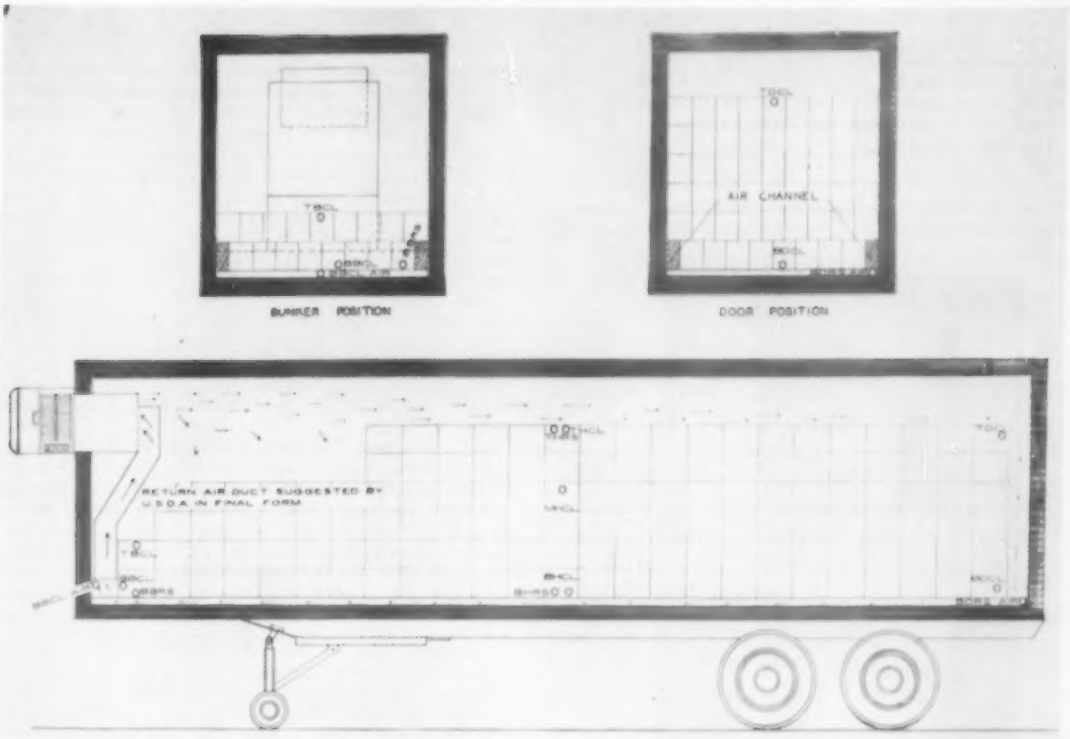


**Figure 2. Diagram of mechanically refrigerated truck with special return air duct installed to increase air circulation under and around load in mechanically refrigerated trailer. Also shown is modified loading pattern to provide air channels along bottom side and supplementary floor racks to increase air movement between load and walls and floor.**

the bottom and side positions near the front of the trailer, showing again the lack of proper air circulation due to inadequate floor and wall clearances.

A test with a different mechanical refrigeration unit was made in December 1952, from Plymouth to Los Angeles *(3)*. Delivery air was conducted from the outlet of the cooling unit to within about 5 feet of the rear doors by means of a cloth duct. The trailer was equipped with special removable metal floor racks to provide an additional inch of space above the regular floor strips. However, sidewall space was only ½ inch or less (Figure 3). The commodity loading temperature ranged from —8° to —4°, with the average top and bottom temperatures both —7°. The thermostat was set at —10° F. for the test run. On arrival in Los Angeles the average top temperature had been reduced to —14°, or a total of 7°. However, the average bottom temperature had risen 7 degrees to zero. The lowest temperature recorded was —15°, and the warmest was 1°, making this an excellent transit refrigeration record. In fact, one of the receivers was heard to remark that it was probably the coldest load that had ever come into Los Angeles. However, the wide temperature range, —15° to 1° F., in the load indicated the need of more space at the floor and certainly more space at the walls to insure greater uniformity of temperature.

**Dry ice systems.** One truck precooling test and 4 transit tests were conducted through August and October, 1952, with a dry ice unit *(6)*. This dry ice system consisted of a welded aluminum ice bunker provided with exterior surface fins welded to 3 thick aluminum shelves on which the dry ice was placed (Figure 4). The heat picked up by the fins was thus readily conducted to the dry ice. Air circulation through the unit and load was provided by 2 fans. One fan drew the air from under the floor racks and passed it over the fins of the dry ice bunker, cycling on and off under control of a thermostat. The second fan operated continuously to maintain constant air circulation around the load without the air passing through the refrigeration unit. To provide for this circulation of air around the load, wooden floor racks were installed and the side walls and rear doors were stripped vertically with wooden slats. In a preliminary test of the first model of this unit, in May 1951 *(2)*, its capacity of 600 pounds of dry ice was found to be inadequate; the bunker was therefore enlarged to hold 900 pounds, which was the capacity of the unit subsequently tested. In the precooling test, air temperature in the truck was reduced from 57° to 0° F. in 18 hours. Precooling was continued for 24 hours, at which time, the dry ice consumption was 790 pounds, an average of 33 pounds per hour.

**Figure 3. View of supplementary aluminum floor racks in mechanically refrigerated trailer. Space between wall and load is inadequate for good air movement.**

In the first transit test, from Florida to San Antonio, Texas, the average temperature rose from —7° to —1°, or 6° in 46 hours, with a maximum temperature of 1.5° at one bottom position. The total dry ice consumed was 1200 pounds, or 27 per hour. In the second test, from Florida to New Jersey, the average temperature rose from —0.2° to 3.2°, or 3.4° in 49 hours. The maximum rise was 5.5° at the bottom bunker position. Total ice consumed was 1208 pounds, or an average of 25 per hour. The third and fourth tests were made in a round trip from Florida to California. In the westbound test, average temperatures rose from —4.3° to 2.9°, or 7.2° in 90 hours. The

**Figure 4. Dry ice bunker showing dry ice left after precooling test. View through access door in front corner of trailer.**

maximum rise, 8° F., was again at the bottom bunker position. Total ice consumed was 1825 pounds, or 20 per hour. The return test encountered such adverse conditions as slow loading and a shortage of dry ice for replenishment in transit; as a result there was an undesirable rise in commodity temperature. Results of these tests emphasized again the importance of proper loading and unloading operations and maintenance of equipment.

A test was conducted in an insulated trailer with dry ice on top of the load *(1)*. After loading, 1625 pounds of dry ice wrapped in paper was scattered over the top of the load and 1000 pounds was added enroute about 48 hours later. About 2325 pounds of dry ice was used during the 60 hours of transit. At loading temperatures of the frozen citrus concentrate were —2° to 0° F. and at destination they had risen to as high as 18°, averaging 6°. Most of the high temperatures were in the bottom positions, with the lowest near or under the dry ice cakes. The distribution of refrigeration was not considered satisfactory.

In October 1952 a test was made with another type of dry ice unit *(4)*. With this kind of unit a secondary refrigerant is circulated by the pressure generated by sublimation of the dry ice from a pressure tank through coils cooled by the dry ice and then through coils suspended from the ceiling of the trailer. The refrigerant then returns to the pressure tank where the cycle is repeated. This flow is regulated by a thermostat located about 10 feet from the rear door. In a standing precooling test of an empty trailer equipped with this unit, air temperature was reduced from 56° to 0° F. in about 12 hours and to —10° in 24 hours. In the transit test from Florida to Philadelphia excellent temperatures were maintained. Loading temperatures were —7.9° to —1.5°, averaging —4.1°, and destination temperatures were —4.6° to 2.0°, averaging —1.9° 72 hours later. Dry ice consumption was about 1800 lbs., or about 25 lbs per hour.

## RESULTS OF STUDIES ON RAILWAY REFRIGERATION

In studies of railway refrigeration of frozen foods a refrigerator car equipped with the same dry ice secondary refrigerant system as the truck just described was tested in January 1952 *(5)*. It was loaded with frozen peas in Jersey City and moved to the car-testing laboratory of the Fruit Growers Express Company in Potomac Yards, Virginia, where it was submitted to a continuous high temperature of approximately 85° F. for 10 days. Average loading temperature of the commodity was 18° and the range was 11° to 20°. On arrival at the car-testing laboratory the average temperature had dropped to —15° and the range was —26° to —4°. The average outside temperature for the 25 hours in transit was about 36°. After exposure of this car to 85° for 10 days the average commodity temperature had risen to only —7°, with a range of —13° to 1°. The conclusion was drawn that this dry ice system in a refrigerator car had ample capacity to refrigerate frozen foods, but its practicability would depend to a considerable extent upon the cost and availability of dry ice.

No recent tests have been conducted on rail refrigeration of frozen citrus concentrate. However, our experience with mechanically refrigerated rail cars indicates that they will provide adequate temperatures. The rapid increase in the production and use of mechanical refrigerator cars is interesting. The latest information indicates that there are approximately 400 now in service and 300 more are being built or are on order (Figure 5).

## FLOOR RACKS

Another phase of the work should be mentioned, namely, tests with corrugated paper floor racks for refrigerated trucks. Because of the importance of adequate space under the floor rack for air circulation and the objection to installation of non-removable heavy racks, a disposable type of floor rack or pallet was developed by one of the paper companies and tested by the Department.

These racks are honeycombed, paper structures 33 x 40 x 1 inch, provided with 3-inch stringers of the same material 4 inches wide and spaced 7¾ inches apart (Figure 5). The design of the

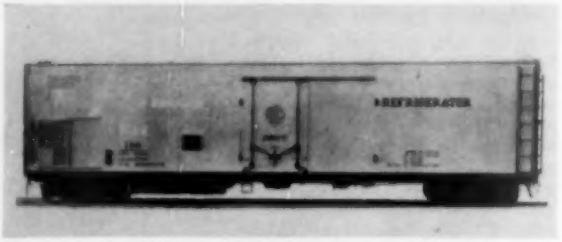

**Figure 5. Latest type mechanically refrigerated railroad car used in transportation of frozen citrus concentrate and other frozen foods. Power is supplied by a diesel-electric unit.**

racks was determined by load-support trials under storage conditions in New York. The racks were used in a series of tests with frozen citrus concentrates from Florida to the New York area during 1953. In the first test, in January, the racks stood up well during the trip and the load arrived in New York in good order. Refrigeration was supplied by a unit installed in the conventional manner. One-half-inch wall strips provided only a minimum of air movement at the sides of the load. The average temperature of the concentrate at loading was —8° F. and at unloading it had risen to —1°, a 7° rise. The maximum temperature, 4°, was again at the bottom of the load at the forward end. This represented a temperature rise of 13° in this position, indicating that, even with the advantage of greater air flow under the racks, more positive circulation was necessary.

In August, 3 trucks were loaded and moved to New York, 2 of which were equipped with similar refrigeration units, while the third was equipped with another type unit. Because of mechanical and other difficulties enroute, two of the trailers

arrived with fairly high temperatures (11° to 16° F.) and therefore the results were not considered valid. The other trailer which had 1-inch-high floor strips and was loaded with concentrate at 2°, had temperatures on arrival ranging from —4° to +8°. Again the maximum temperature was in the bottom of the load.

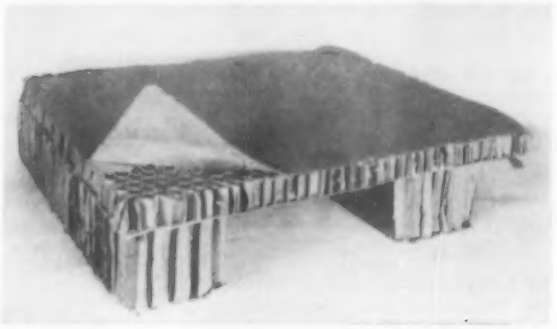

**Figure 6. Honeycombed-paper pallet, showing internal construction.**

The final 2 tests were run in December with trailers with conventional installations of a commonly used unit. In one trailer a canvas cloth duct was used for spreading the delivery air along the ceiling. For this test the pallet stringers, instead of being continuous were made up in short blocks to allow lateral movement of air. This was to provide better circulation down the sidewalls. One trailer had 1½-inch ribs on the walls, while in the other pallets provided the same air space at the sides of the load as on the floor (Figure 7). The first trailer

**Figure 7. Honeycombed-paper pallets in place in refrigerated trailer under load of frozen citrus concentrate. These were also used to provide additional air space between load and sidewall.**

also had air channels at the bottom corners as shown in Figure 2. After loading, temperatures of the concentrate in this trailer averaged —4.5° F. and at unloading they had risen to only —2.5°, a 2° rise. The range in unloading temperatures was —8.2° to +0.5°. This was the best record for units of this type but it must be remembered that the test was made in December with outside air temperatures averaging near 40°. In the second trailer, average temperatures rose from —5.8° to —1.3°, a 4.5° rise, with maximum of +1°, also a good record. In both tests, the thermostats were set at —5°. The benefits of providing adequate space for air circulation around the load were demonstrated by these tests with pallets.

## CONCLUSIONS

The results of the past three years' tests with refrigerated trucks may be summarized as follows:

1. Better refrigeration by mechanical units that use a blower for air distribution may be obtained when a more positive air return is provided by a return-air duct from the floor.

2. Dry ice provides adequate refrigeration with either a blower-type unit or overhead cooling coils if the capacity of the unit is about 1000 lbs. of dry ice and an ample supply is constantly available during the transit period.

3. A 1- to 2-inch air space should be provided along the walls and a 2- to 4-inch one on the floor.

4. Disposable honeycombed-paper pallets provide acceptable temporary floor racks and may also be used for temporary wall racks.

5. Thermostats should be set at —5° F. or lower.

6. Frozen citrus concentrate should not be loaded at temperatures above 0° F., and —5° to —10° is preferable. Every precaution should be taken to protect it from warming up during loading and unloading.

## LITERATURE CITED


1. Garver, C. Elliott, Gerrity, M. V., Winston, J. R., and Cubbedge, R. H. A test comparing dry ice and mechanical refrigeration in the transportation of frozen citrus concentrate by motortruck. (An interium report) U.S.D.A., PMA (February 1953).
2. Hall, J. D., Walton, A. B., Johnson, H. D., Redit, W. H. Transportation test of dry ice refrigerated truck trailer—Florida to Chicago—May 1951. U. S. D. A., H. T. & S. Office Report No. 252, July 1951.
3. Johnson, H. D., and Garver, C. Elliott. Test of a mechanical refrigeration unit designed to maintain low temperatures in motortruck transportation (An interim report) U. S. D. A., PMA, March 1953.
4. Johnson, H. D., and Garver, C. Elliott. Test of a refrigerated truck trailer equipped with a dry ice system of refrigeration using a secondary refrigerant. (An interim report) U. S. D. A., PMA, April 1953.
5. Johnson, H. D., Gerrity, M. V., Worthington, J. T., and Redit, W. H. Test of a refrigerator car equipped with dry ice system of refrigeration. U. S. D. A., PMA, April 1952.
6. Johnson, H. D., Gerrity, M. V., Winston, J. R., and Cubbedge, Randall. Some refrigeration tests of a motor truck-trailer equipped with one type of dry ice system of refrigeration. (An interim report) U. S. D. A., PMA, April 1953.
7. Redit, W. H. Mechanical refrigeration in the transportation of perishable food. *Food Technol.*, 6, 86 (1952).
8. Redit, W. H., Johnson, H. D., Hall, J. D., Cubbedge, R., and Kaufman, J. Transportation of frozen citrus concentrate by railroad and motor truck from Florida to northern markets. U. S. D. A., *Agri. Info. Bull.*, 62 (June 1951).

# Citrus By-Products and Derivatives—An Introductory Survey[a]

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(Manuscript received July 13, 1954)

Citrus by-products, at least research on citrus by-products, is probably an ill afforded luxury for private corporations in the citrus juice business. On the other hand it is a vital necessity to a citrus cooperative. This seeming paradox is not difficult to explain. Juice in one form or another is by all odds the greatest value to the processor of sound, mature citrus fruit of the varieties with which we are mostly concerned; namely, Valencia oranges. Marsh grapefruit, Lisbon, Eureka and Villafranca lemons. This is the condition today and this is likely to be the condition which will prevail as long as citrus juices of fresh flavor can exert their direct appeal to the consuming public.

The modern producer and distributor of high quality citrus juices desires, therefore, to make these appealing products at the right time to get prime quality. Such a producer will purchase his fruit supplies to meet these needs and he will refrain from purchasing fruit that does not meet his quality requirements. He wants his plant designed to do one thing; to make high quality juice at a reasonable cost. He wants no dilution of this effort by attention given to incidental steps of processing of other portions of the fruit nor does he care to handle nonjuice fruit simultaneously with the juice production operations.

However, when we come to the citrus cooperative we have quite another picture. The cooperative has no choice in the matter. It must of course produce only the highest quality juice products from that portion of its fruit receipts which is suitable, but must, in addition, provide as profitable an outlet as possible for the remaining portion of its fruit supplies. It must stand ready to accept fruit deliveries 24 hours a day and 365 days a year every year. This is the time (at least in California) the growers' trees are serving their owners and are requiring the service of the best supplemental facilities which the growers can make available to see them through good years and bad, frost years and mild seasons.

Citrus products history recalls several instances, prior to the success of processed juices, where some single product was insufficient to sustain a profitable operation. Research has been quite necessary, then, to promote diversification of products in order to return at least the costs of processing nonjuice fruit. The cooperative must have such diversification to carry through the years when much fruit is unsuited for quality juice production.

What has just been said is amply substantiated in the case of pectin. Despite the fact that citrus pectin for many years appeared deserving of much research on the part of the cooperatives' and of State and Federal laboratories, less than 20% of the available fruit is used for pectin production. There is not an immediate market for more. Other saleable peel products became imperative, and so new pectic substances and flavonoids were among those developed. The old stand-bys, oil of lemon U. S. P. for flavor and dehydrated orange meal for cattle feed, continue as important items necessary in the aggregate to pay the processing and handling costs and part of the growing costs accruing to nonjuice fruit.

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

## CLASSIFICATIONS

By-products and derivatives can be broadly classified under the essential oils, pectic substances, flavonoids, molasses, dried meal cattle feed, citric acid, citrates, and specialty items. The industries served by these are food, feed, pharmaceutical, and chemical.

**Oil of lemon and other citrus oils.** Considered in the light of world history, the oldest citrus by-product is oil of lemon. At one time in the not too distant past citrus, as an industry, was very largely the growing of lemons for the production of lemon oil in Sicily and Italy. The hand pressing or sponge method which was used required preparation of the fruit consisting of scooping out the pulp or juicy meat so that the peels could be flexed over a supported sponge and thus the oil released. The juice in most cases was a waste product, later becoming a by-product in the sense that it was utilized for its citric acid content for the production of citrate of lime. The citrate of lime was shipped to citric acid producing countries under a well regulated quota arrangement which maintained the price of citrate of the lime at a rather high level. Eventually both the lemon oil and the citrate of lime production ceased to be the monopoly of Sicily and Italy, production of both items having started about 1900 in California.

The early uses of lemon oil and also of orange oil were related to the perfumery, medical and pharmaceutical professions. While at present the food and beverage requirements far exceed those of the pharmaceutical industry, the earlier association still exerts its effect. This is because these oils, in most consuming countries, are governed as to specifications by whatever pharmacopoeia or codex is official in the country involved. For example, although revised in recent years, the U. S. P. primarily directs its controlling force toward assurance of authenticity, production by a prescribed method to give a natural uniformity, and absence of contaminants. For many food product uses the permissive addition of suitable antioxidants would effect substantial improvement—improvement which might be equally welcome in pharmaceutical uses of the oils—so it is not unreasonable that the pharmacopoeia should recognize such additions.

It is partly for increasing the stability of citrus oils in the absence of added antioxidants and partly to achieve greater intensity of flavor that concentrated oils are used in some beverage bases and similar preparations.

The concentration is usually effected by vacuum evaporation of a substantial part of the limonene, the lowest boiling major constituent of citrus oils. It is true that limonene is less valuable as a contributor of flavor than oxygenated constituents, and limonene is more subject to oxidation than are the aldehydes, esters and alcohols. However the concentrated oil, for most food purposes, loses something of flavor value as compared with the original or whole oil. This is true in the opinions of the users of oil even though the concentration is effected by means other than evaporation, such as chromatographic separation or partition between immiscible solvents. There is therefore a definite place

for antioxidants in citrus oils and probably in many other food flavors.

Another method of protecting oils is that known as entrapped flavors. This is an old idea, that of solid emulsions of oil as the dispersed phase. There have been new advances, however, regarding specific selection of the entrapping agents such as sorbitol and specific applications of the finished product, for example to citrus juices which have been dried under high vacuum from low temperature-concentrated juices. Such juices need some flavor fortification.

The uses of citrus oils are classified primarily in the field of flavors. From time to time, research work has been conducted in many quarters in an effort to develop new uses for these oils. It is paradoxical that over the centuries during which citrus oils have been prominent articles of commerce, adulteration with turpentine has been recorded in the Sicilian and Italian history and conversely use of lemon oil as a substitute for turpentine in the Naval Stores Industry has been recorded. The major constituent of citrus oils, limonene, is an excellent solvent with pleasing odor, but other terpenes such as dipentene derived from the pine oil industry are much cheaper. In most periods the demand for citrus flavors is such as to make unattractive non-flavor uses of any of the cold pressed citrus oils which include, lemon, orange and grapefruit in the United States, and these together with Bergamot and lime oils in other countries.

**The pectic substances.** Turning to another area, the pectic substances have perhaps offered the greatest challenge to citrus products research. Here is a very large potential awaiting lower production costs or additional, new specific uses which would bear the present costs. The cost of production of pectin and of most pectic substances is connected directly with their most important character namely their strong hydrophilic nature. This water holding ability determines gel forming properties. High viscosity of the aqueous solution of pectin necessitates extraction, handling and filtration to remove the insoluble associated cellulose and other insolubles at a very low concentration, usually less than 0.5%. Even under these conditions the filter aid requirement is heavy. Following filtration there is the reverse process of water removal. The only currently successful processes for water removal end with displacement and extensive washing with an alcohol, usually isopropanol, followed by vacuum drying for removal and recovery of the alcohol. Pectin and all the more common pectic derivatives are insoluble in alcohol whereas alcohol is a good solvent for most of the water soluble impurities associated with pectin extraction. Aside from labor costs and fruit costs the filter aid requirement and alcohol losses constitute two of the most important pectin production costs which are inherently associated with the desirable pectin properties.

Striving for lower costs, however, has been but one effort of pectin research. Tailoring the finished product to the demands of the user has required much effort and has been attended with much success. Jelly grade is a term peculiar to the pectin industry. It is the number of parts by weight of sucrose which one part by weight of the pectin preparation will carry to standard firmness in a jelly of specified composition and at 65% total soluble solids. It is a measure of uniformity and a rough guide to the preserver in setting up an original formula. Jelly grade certainly is the most important single measure of the performance of the pectin but now recognized are such other factors as time of set, that is whether slow setting or rapid setting, or temperature of set, whether low or high, texture, clarity and color factors and many others. These refer to regular pectins which depend upon the presence of high sugar content which together with the required acidity convert fruit juices to pleasing table jellies as fruit pectins have done for centuries. We might say in passing that despite much very good work on the basic mechanism of pectin jelly formation, there is still plenty of room to get good arguments in this area.

In recent years we have seen steady progress in use of another pectin—one which does not require sugar for its performance—but still pectin by all chemical standards. This is the so-called low methoxyl or low ester pectin which the late Prof. George Baker can be credited for starting on its way.

*Low Methoxyl Pectins.* Low methoxyl pectins are made by 3 different processes in addition to the acid extraction, concentration, alcohol washing of all pectins. All 3 low methoxyl pectins have one step in common, the process of de-esterification or rather selective partial de-esterification, but the method of achieving this is greatly different in the three. One uses a severe acid process for de-esterification, the second an enzymatic de-esterification and the third de-esterification by means of alkali. This third process in turn should be divided into 2 subgroups. One is the use of the fixed mineral alkali such as sodium hydroxide which has generally not been successful, and the other makes use of ammonia usually in alcohol which gives a very desirable and versatile product. Actually the product resulting from the ammonia-alcohol process is best described as a partially methylated polygalacturonic acid amide inasmuch as there is a small increase in amide nitrogen which attends the de-esterification process.

The future of low methoxyl pectins is generally good. To be sure a great deal depends on the continued interest in the low calorie foods such as gels sweetened with non-nutritive substances, saccharin or cyclamate (Sucaryl). In this field, where the total soluble solids are low, low methoxyl pectin is specifically required for gel production. Besides artificially sweetened gels, there are other preparations of low solids where low methoxyl pectins are indicated, the most notable being tomato aspic. Canned tomato aspic made with low methoxyl pectin is considered generally superior to aspics using other gel agents. Such gels are heat reversible and the low methoxyl gel agent is reasonably heat stable in mildly acid media during these transformations and during the original processing.

**Flavonoids.** The flavonoids of citrus fruits have been used to date largely in the pharmaceutical industry. Here, hesperidin, hesperidin methyl chalcone, lemon peel infusion and, to a lesser extent, naringin from grapefruit, have constituted the group known as citrus bioflavonoids. Work in Florida, Texas, and California, has indicated uses of citrus flavonoids in fields other than the pharmaceutical, but production costs mitigate against commercial development of many of these.

**Dried meal.** The preparation of residual citrus peel and pulp for cattle feed involves light liming to firm the pulp and facilitate pressing. The peel juice pressed from limed peel contains nearly as much total solids as the remaining pressed peel. However, the peel so pressed is more readily dried than would be the case if the peel juice had not been removed. The pressed peel juice, usually containing about 10% total soluble solids, is evaporated in triple effect to produce citrus molasses having properties generally similar to beet or cane molasses. Outlets for citrus molasses include cattle feed and as a carbohydrate source for microbiological conversion to other products such as ethyl alcohol, methane, citric acid, and torula yeast for cattle feed. Other than the first named, ethyl alcohol, we are not aware of any commercial production, but considerable experimental work has been conducted with all the foregoing.

Dried citrus meal as a cattle feed is probably the most universally produced citrus by-product in the United States citrus industry. Dried citrus meal is generally considered approximately equivalent in food value to Pacific Coast barley or perhaps it should be placed between barley and beet pulp. Milk and even butter fat production has been repeatedly claimed to show increases with the feeding of citrus meals but, whether or not these claims are justified, the chemical analyses of citrus meals place them among the more widely accepted feeds for beef cattle and dairy cows.

**Citric acid.** As previously stated, citric acid production from by-product lemon juice was one of the earliest outlets for surplus lemons or lemon waste, first in Sicily and Italy and later in California. This is a declining rather than an increasing activity and will be so unless microbiological production from citrus molasses develops to be commercially attractive. The method of recovery is the time-honored Scheele process, precipitation with lime, boiled for growth of the calcium citrate crystals to facilitate filtration, The citric acid is regenerated with sulfuric acid and crystallization as anhydrous or monohydrate follows many steps of purification. The decitrated juice is not ordinarily recovered.

**Citrates.** Citrates are of lesser importance as a direct citrus industry by-product now as compared to former years despite

the fact that citrates as well as citric acid continue to increase in importance in the American chemical industry.

**Specialty items.** Production of specialties in the California citrus industry by-product category include galacturonic acid, galacturonates, pectin specialties, pectates, and pectate pulp, and, on an experimental scale, at least, the bitter principle, limonin, and others.

### A FINAL CONSIDERATION

Let us now turn to another phase of citrus technology. Manufacturers of citrus products must constantly remain aware of the trend in pesticides used by the growers to improve quality and quantity of their crops. The problem here, of course, is not different in general principle from that of any processor of agricultural commodities. However, there is one feature which demands consideration by all of us in food processing.

Ordinarily the juice or edible portion of citrus fruit is well protected from penetration of pesticides. Whether it be the new synthetic organic chemicals or the older mineral insecticides, we have seen no appreciable residues inside the fruit. The surface residues of the older pesticides were well eliminated through the packinghouse washing which the fruit undergoes whether being packed for fresh fruit market or coming to the products plants where the fruit is again washed. The newer organic pesticides, however, find their way in some instances to the oil cells and a substantial residue may appear in this location and in the extracted oil—substantial at least when expressed in p.p.m. as compared with p.p.m. in the juice or edible portion. Any risk to the users of citrus oil is clearly nonexistent because of the very small quantities required as a flavor or for medicinal uses.

Experience over thirty years in the field of diversified citrus products including edible juices and concentrated juices has indicated to us very strongly the desirability of taking such factors into account in some suitable manner. We have proposed therefore that, in the interest of safety and simplicity, the tolerances for pesticide residues be expressed in p.p.m. on the basis of the nonaqueous matter instead of the present practice of fresh or "as is" weight of the food product. This concept recognizes in a realistic way the necessity of safeguarding the public, of which we ever remember we are a part, in all derivatives of any agricultural commodity, not just the commodity in its raw or natural form. It does not seek to change a residue tolerance once established at a safe level for a fruit or vegetable, but it provides extension to concentrated juices, dried juices, liquid pectins, powdered pectins, oils and other derivatives. This it does on the sound premise that addition or subtraction of water does not alter the inherent food requirements which are best reflected by the intake of nonaqueous matter.

# Amount and Character of Connective Tissue as It Relates to Tenderness in Beef Muscle[a]

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(Manuscript received July 12, 1954)

**Differences in the amount and character of connective tissue from a wide variety of beef samples of known history are reported. Differences are related to the tenderness of the heated meat, previously determined. Data indicate that collagenous and elastic fibers influence tenderness.**

Among the first sensory impressions that one has when eating a piece of meat relates to its tenderness. What is this all important quality and what factors are responsible for the attributes of tenderness or toughness? It has been determined through experience that (a) beef from freshly slaughtered animals during *rigor mortis* tends to be tougher than that from beef aged 10 or more days; (b) beef from young animals is more tender than that from older mature animals; (c) beef from well-fattened animals is generally more tender than that from lean animals and (d) certain muscles are more tender than others.

Research workers have learned much about the factors responsible for tenderness. They have found revealing chemical differences in the connective tissue of animals of different ages and among the "working" and "lazy" muscles of the same carcass. As a beef animal fattens, the muscle bundles are known to swell or enlarge to some extent. It has been shown that as the animal becomes more mature, the muscle fibers increase in size. Enzymes, acids, and doubtless other agents change the character of muscle tissue during and after chilling and aging.

Meat from animals of similar breeding, feeding, age, and method of handling has been shown by test to be quite different in degree of tenderness. The direct causes of tenderness or toughness in beef must be deter-

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, July 1, 1954.

[b] Contribution No. 956 of the Massachusetts Agricultural Experiment Station, in cooperation with the U. S. Department of Agriculture.

mined if we are to produce more tender beef. Further study must be made of the fibers and connective tissue of beef, for example, to identify the variations and to associate them with differences in tenderness. This study was undertaken to contribute to this purpose; specifically, to record and compare the differences in amount and character of the connective tissue from a wide variety of beef samples of known history and to relate them to the previously determined tenderness of the heated meat.

## REVIEW OF LITERATURE

Moran and Smith *(18)* reported that connective tissue was the major factor contributing to toughness. However, Steiner *(22)* measuring toughness of meat cooked in a 0.5% salt solution with the Volodkewich apparatus found that both muscle fiber proper and collagenous fibers of the connective tissues contributed to the resistance across the grain of lean meat, but that only the collagenous fibers contributed to the resistance along the grain. He concluded that increases in tenderness with aging are due to an effect upon the muscle fibers rather than upon the connective tissue.

Hoagland, McBryde, and Powick *(6)* concluded from work on storage beef that, although several changes had occurred, the increase in tenderness was due almost entirely to autolysis. They observed a progressive rise in noncoagulable nitrogen with increased storage time.

The increase in activity of cathepsin (an enzyme found in various animal cells) together with a decrease in pH values was believed by Bradley *(1)* to be related to increase in tenderness; whereas, Smorodintsev and Nickolaeva *(20, 21)* reported that when meat is stored at 0° to 4.4° C. (32 to 40° F.) cathepsin decreased 40 to 45% in the first 24 hours *post mortem* and another 20% in the next 5 days. Less elasticity in muscle of fattened cattle as compared to lean cattle, when both were held for the same length of storage, was found by Golovkine, Zelentosov, Smirnov, and Shkolnikova *(3)*. They reported that glycogen content and lactic acid were determining factors in the resistance of the muscle. Percentages of alkali-insoluble protein were reported by Husaini, Deatherage, Kunkle, and Draudt *(8)* as having a correlation value of —0.87 with tenderness. Tenderness scores were determined in duplicate by the method of Deatherage and Reimer *(2)*. Husaini, Deatherage, Kunkle, and Draudt *(8)* found no relation between tenderness scores and total nitrogen, trichloracetic acid soluble nitrogen, non-protein nitrogen or heat coagulable nitrogen. In a later study Husaini, Deatherage, and Kunkle *(7)* could not confirm their former results, especially after 3 days aging; however, after 15 days aging, there was a correlation, but it was not high. They found no relationship between tenderness and muscle hemoglobin after 3 days of chilling, but a very significant correlation after 15 days. They concluded that connective tissue as alkali-insoluble nitrogen and muscle plasma as represented by muscle hemoglobin are in part responsible for tenderness in meat.

Mitchell and Hamilton *(16)* found that tenderness was a function of collagen and elastin in connective tissue. Therefore, tenderness was correlated with connective tissue character and content of beef muscle as determined chemically. It has also been found by Mitchell, Hamilton, and Haines *(15)* that less tender cuts of meat contained more collagen than the more tender. This has been confirmed by Mackentosh, Hall and Vail *(10)*. Mitchell, Hamilton, and Bull *(17)* in a study of baby beef and yearling beef found that the collagen content of the muscle was highly indicative of an age effect.

Great variations in texture of muscles as determined by the size of the bundles *(fasciculi)* and the amount of connective tissue *(perimysium)* surrounding the bundles was reported by Ramsbottom, Strandine, and Koonz *(19)*. They report well-defined *fasciculi* and extensive *perimysium* in the superficial pectorial muscles, but only small amounts of connective tissue in the *psoas major*.

## NATURE OF CONNECTIVE TISSUE

For the purposes of this study, connective tissue may be divided into two main parts; (a) the collagenous or white fibers and (b) elastic or yellow fibers which are embedded in an amorphous ground substance, jelly-like in nature, which "cements" them together.

The collagenous fibers are soft and flexible and offer considerable resistance to a pulling force; however, they lack elasticity. Collagenous fibers are long, straight or wavy, fine fibrils that run in all directions. It is almost impossible to find where they terminate. These fibers or fibrils generally appear in bundles, cemented together, which branch into smaller bundles. The smaller bundles often branch out into single fibrils and appear between muscle fibers.

The collagenous fibers are proteinaceous in nature, giving several but not all of the typical protein reactions. Due to this characteristic, they have been called albuminoid. When collagen is boiled in water, it dissolves and forms a colloidal solution of gelatin which becomes jelly-like when cooled. The collagenous fibers swell when placed in dilute acids and strong alkalies. They are also easily digested by pepsin in acid solution but resist trypsin in alkaline solution. With heavy metals, collagen forms an insoluble product, the basis of the tanning of leather. Collagenous fibers are difficult to stain, as they have no specific staining reaction. Lee *(9)* stated that to stain collagen permanently requires "acid" dyes. Maximow and Bloom *(13)* stated that acid aniline dyes such as acid fuchsin of the Van Gleson stain, or aniline blue of Mallery's mixture, stain the collagenous bundles sharply, especially after treatment with mordants.

The elastic or yellow fibers occur in the connective tissue as a loose network of fine fibers that branch and anastomose in various directions. Elastic fibers are homogenous and not fibrillar as are collagenous fibers. As a rule, elastic fibers appear as straight branching fibers. Upon stretching, they yield readily, but return to their normal length when released. If the fibers appear in large numbers, as in the *ligamentum nuchae*, they are yellowish in color.

Elastin, an albuminoid, is the principal constituent of elastic fibers. Elastin is very resistant to boiling water, acids, and alkalies, but it can be digested slowly with pepsin and trypsin. Elastic fibers differ from collagenous fibers in that they will stain differentially with orcein and resorcin fuchsin. Lee *(9)* reported that elastin will stain with either acid or basic dyes but has a special affinity for orcein.

## EXPERIMENTAL

**Origin of meat samples.** The samples used in this study were the fixed halves of those reported on earlier by Hiner, Hankins, Sloane, Fellers and Anderson *(5)*. A total of 52 beef and veal animals that had been slaughtered, chilled, cut, sampled, and mechanically tested for tenderness under uniform conditions were used. Of this number 3 were two-month-old veal calves; eight were 500-pound steer calves, 7 months old; twenty-five were 900-pound steers, 14 months old; 8 were barren heifers, 3 years old; and 8 were mature cows, approximately 5½ years of age. The animals were all of the Shorthorn breed, beef and dual-purpose type or crosses between the two types.

**Preparation of samples for testing.** After aging for 12 to 15 days at 0.6 to 1.7° C. (33 to 35° F.) each dressed beef carcass was cut into its primal cuts. From these primal cuts 9 one-and one-half-inch pairs of samples were removed for study. Each primal cut was represented by one or more samples. The 9 samples were from the following locations, (a) neck, 6th cervical vertebra; (b) foreshank, across radius and ulna bone near elbow joint; (c) 3rd rib, at 3rd thoracic vertebra; (d) across humerus or round bone of chuck; (e) 8th rib, at 8th thoracic vertebra; (f) 3rd lumbar vertebra; (g) psoas major (tenderloin) below 6th lumbar vertebra; (h) rise of pelvic arch (loin end), and (i) 1½ inches from cut surface or face of the round. Each group of 9 samples was from one side and each group of animals was represented by an equal number of samples from the right and left sides.

On or about the 14th day of aging, the 9 samples from each animal were tested for tenderness after heating to an internal temperature of 60° C. (140° F.). Prior to weighing and heating, small cubes of muscle approximately 12 mm. on a side were dissected and fixed for histological study. The histological samples were taken from the largest muscle in the prepared sample. To avoid variables due to location, each sample for histological study was removed about one-third of the distance in from the surface on the longest diameter of the muscle. As soon as the sample was removed it was placed in 50 ml., 10% formalin solution where it remained 5 to 8 days.

The cube samples for histological study were removed from the following muscles, all of which are classified as voluntary and striated; neck, *serratus ventralis;* foreshank, deep digital flexor; 3rd rib of chuck, *longissimus dorsi;* cross-arm of chuck, *triceps brachii;* 8th rib, *longissmus dorsi;* short loin, *longissmus dorsi;* tenderloin, *psoas major;* sirloin, *gluteus medius;* and round, *semimembranosus, semitendinosus,* and *biceps femoris* muscles.

After fixing, the muscle samples were removed from the formalin solution and cut in half, lengthwise. Half of each sample was trimmed into a rectangular block. The blocks of tissue were embedded in paraffin by the usual procedure of dehydrating in increasing concentrations of alcohol (70% to absolute), followed by xylene, xylene and paraffin; and finally embedded in paraffin. The second half of the sample was returned to the formalin solution for studies on fiber diameter.

The 52 sets of muscle samples which were embedded in paraffin were sectioned longitudinally at 10 microns on a rotary microtome. Half of these samples, selected to represent animals of each age group, were also sectioned transversely. Inasmuch as muscular tissue has a tendency to curl, true longitudinal and transverse sections were not always obtained. The sections were mounted on glass slides preparatory to staining.

**Staining procedure.** As explained previously, collagen and elastin stain differently, the former being difficult to stain selectively and the latter relatively easy. Therefore, numerous dyes and staining procedures were studied before the following were adopted as being most effective for characterizing the collagenous and elastic fibers: Collagenous fibers, Malloy's Aniline Blue *(11, 12)* elastic fibers, Taenzer-Unna Orcein *(23)* and Verhoeff's Elastic Tissue stain *(25)*. A triple stain was used to stain both collagen and elastic fibers in the same section, consisting of Weigert's Resorcin Fuchsin *(26)*, Mayer's Acid Alum Hematoxylin *(14)* and Van Gieson's Picric Acid and Acid Fuchsin *(24)*.

## RESULTS

Sections of the 11 muscles from all the cattle were examined for collagenous and elastic fiber distribution and content. Figure 1 shows photomicrographs representative of longitudinal sections of muscle fibers of the 4 degrees of tenderness from a 500-pound steer calf and a cow. Figure 2 shows the same muscles in cross-section. It has been previously shown by Hiner and Hankins *(4)* that for each of the 5 age groups, the samples classified themselves into 4 tenderness groups, as follows: (a) the least tender, neck and foreshank; (b) round; (c) the 2 chuck samples, 8th rib, short loin and loin end; and (d) the most tender, the tenderloin. The 3 muscles of the round, *semimembranosus, semitendinosus* and *biceps femoris* showed little difference in tenderness. Furthermore, they found that as age of animal increased, tenderness decreased for each of the 9 samples. In general, this same classification was reported by Hiner, Hankins, Sloane, Fellers, and Anderson *(5)* for diameter of muscle fibers. The relationship between all samples and fiber diameter was curvilinear with a correlation of 0.83. Furthermore, they report that analysis of variance showed fiber diameter and tenderness of the animal and samples to be very highly significant but the interaction of the two was only significant.

As shown in Figure 1 the elastic fibers were located between the muscle bundles, with few exceptions, when examined in longitudinal sections. However, in cross-section (Figure 2), it will be seen that most of the elastic fibers were present between the larger muscle bundles, with a small amount around the primary bundles. In some instances thick bands, as seen in Figure 2 D, were found. Upon closer examination, these areas showed numerous elastic fibers dispersed throughout the muscle fiber. Such an arrangement of connective tissue was found frequently in the serratus ventralis, deep digital flaxor, semimembranosus, semitendinosus and biceps femoris muscle when using orcein or Verhoff's staining procedure.

In an attempt to evaluate objectively elastic fibers present in the muscles studied, 3 factors were considered; distribution, amount, and size. To each of these, numerical scores from 1 to 5 were assigned as follows: Distribution, 1—*very scattered*, 2—*scattered*, 3—*tending to form groups*, 4—*recognizable in grouping tendencies*, and 5—*grouped in a more or less tight group;* amount, 1—*small number* (can *be counted*), 2—*more numerous* (cannot be counted), 3—*very numerous*, 4—*abundant*, and 5—*very abundant;* size, 1—*very narrow* (only visible with high power), 2—*narrow*, 3—*moderately wide*, 4—*wide*, and 5—*very wide*. The final score for the evaluation of the factor of elastic fibers was the sum of these 3 subjective evaluations. In the results of this evaluation for each of the age groups (Table 1) it will be noted that the final evaluation varies from 6 for *psoas major* to 15 for deep digital flexor muscles, respectively.

Upon closer examination of these photomicrographs, it is seen that in the samples with a high resistance to shearing, the elastic fibers were very abundant. However, as the resistance to shearing decreases, the number and amount of elastic fibers present decreased to a point where only a few scattered ones were found, Figure 1A and 2A. In the more tender *psoas major* muscle, few or no elastic fibers were observed around the primary muscle bundles. The distribution of the elastic fibers in the connective tissue presented a scattered appearance in the more tender samples, especially those samples representing the chuck, rib, and loin. However, in the less tender round muscles, the elastic fibers tended to become bunched into definite areas. This characteristic was especially pronounced in the neck and foreshank sections.

The size of the elastic fibers in the younger veal and steer calves was noticeably smaller than in heifers and cows. This characteristic was also found when comparing the elastic tissue of serratus and psoas muscles in any group.

A study of these sections indicates that in those muscles where any movement and/or work is required, the elastic fibers are larger and more bunched. On the other hand, in those muscles where little or no strain is attached, the elastic fibers are narrow and more dispersed. This would indicate that muscle function has a definite bearing on size, distribution and amount of elastic tissue found in beef muscle. As the animals matured there were indications that size of elastic fibers increased. This increase in size could very well be a factor in the increase of shearing resistance discussed earlier and found to be associated with maturity.

The collagenous fibers also contributed a much larger portion of the connective tissue than did the elastic fibers. They were found to be most abundant between the large muscle bundles with evidence that they were scattered between individual muscle fibers.

Figures 3 and 4 represent the same animals and muscles as shown in Figures 1 and 2, but the sections were stained with aniline blue. A study of these photomicrographs, which are representative of steer calves and cows, indicates that collagenous fibers formed bunches with numerous branchings and rebranchings. The amount of collagen varied between muscles, being much more abundant in those muscles with more resistance to shearing. The amount of collagenous fibers in the various samples tended to overlap considerably. This was especially true when considering the age differences. Part of this difficulty was due to the effect of fat deposits which formed between collagenous fibers and separated them, either singly or as small bunches.

From a study of the sections and from Figures 3 and 4, it appeared that the collagenous fibers increased somewhat in size with increased maturity. However, there did not appear to be much difference in size within any one age group.

In order to make a comparative study of collagenous and elastic fibers in any one section, a triple stain was used. Representative sections showing the results of this method of study are shown in Figures 5 and 6. In all cases the photomicrographs

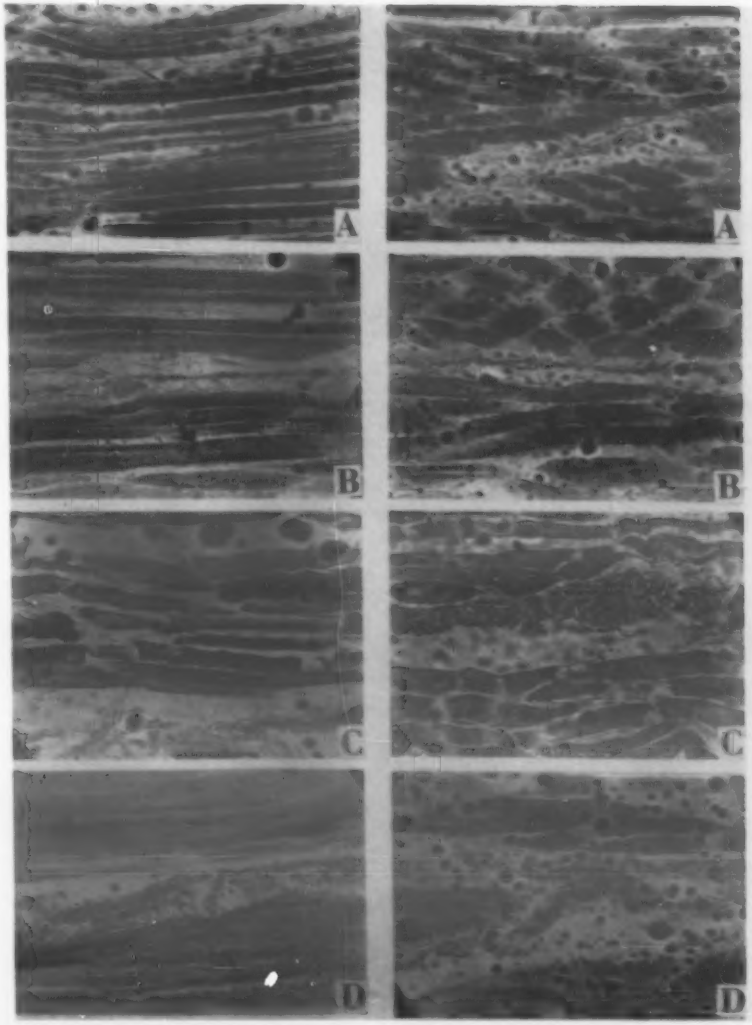


Figure 1. Photomicrographs of representative longitudinal sections of beef muscles from a 500-pound steer calf (on left) and cow (on right) stained with orcein to differentiate elastic fibers: A, psoas major (tenderloin); B, longissimus dorsi (eighth rib); C, biceps femoris (round); D, serratus ventralis (neck). (240 ×)

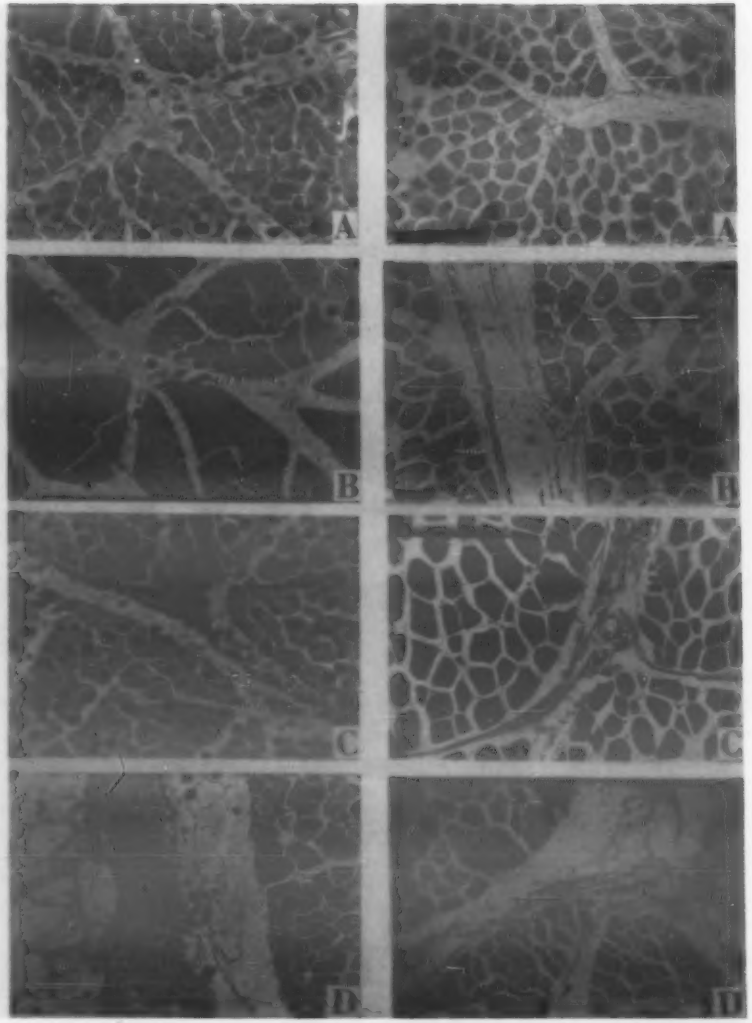


Figure 2. Photomicrographs of representative cross-sections of beef muscles from a 500-pound steer calf (on left) and cow (on right) stained with orcein to differentiate elastic fibers: A, psoas major (tenderloin); B, longissimus dorsi (eighth rib); C, biceps femoris (round); D, serratus ventralis (neck). (240 ×)

Figure 3. Photomicrographs of representative longitudinal sections of beef muscles from a 500-pound steer calf (on left) and cow (on right) stained with aniline blue to differentiate collagenous fibers: A, psoas major (tenderloin); B, longissimus dorsi (eighth rib); C, biceps femoris (round); D, serratus ventralis (neck). (240 ×)

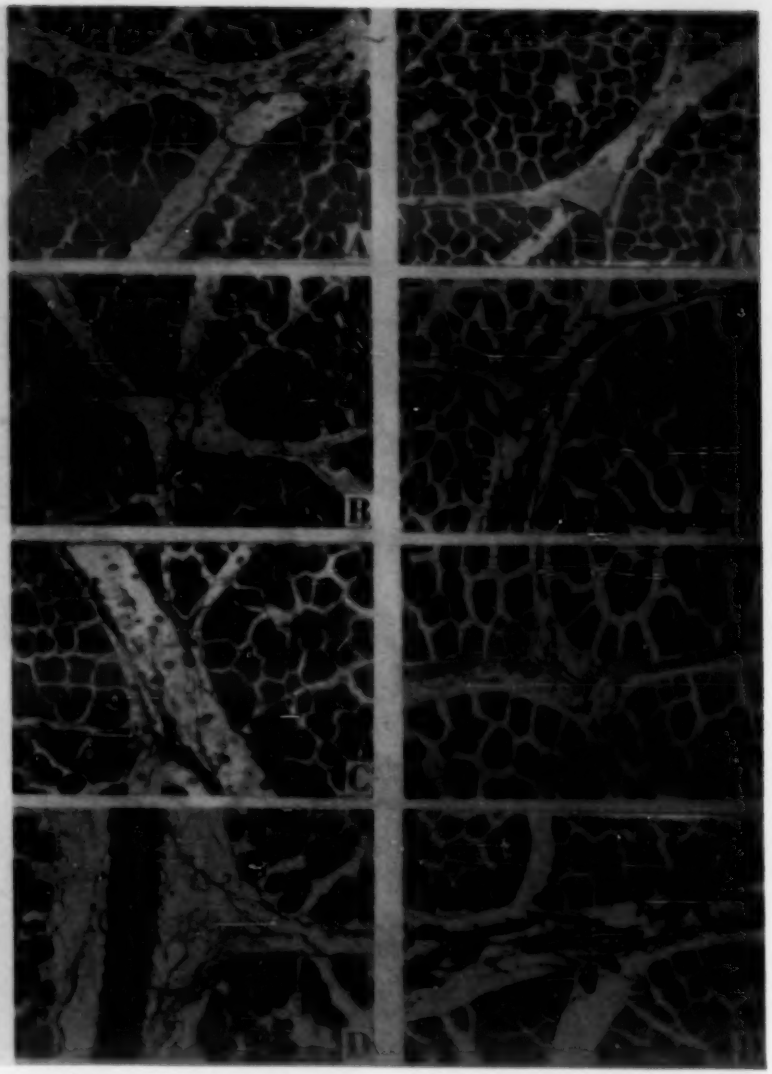


Figure 4. Photomicrographs of representative cross-sections of beef muscles from a 500-pound steer calf (on left) and cow (on right) stained with aniline blue to differentiate collagenous fibers: A, psoas major (tenderloin); B, longissimus dorsi (eighth rib); C, biceps femoris (round); D, serratus ventralis (neck). (240 ×)

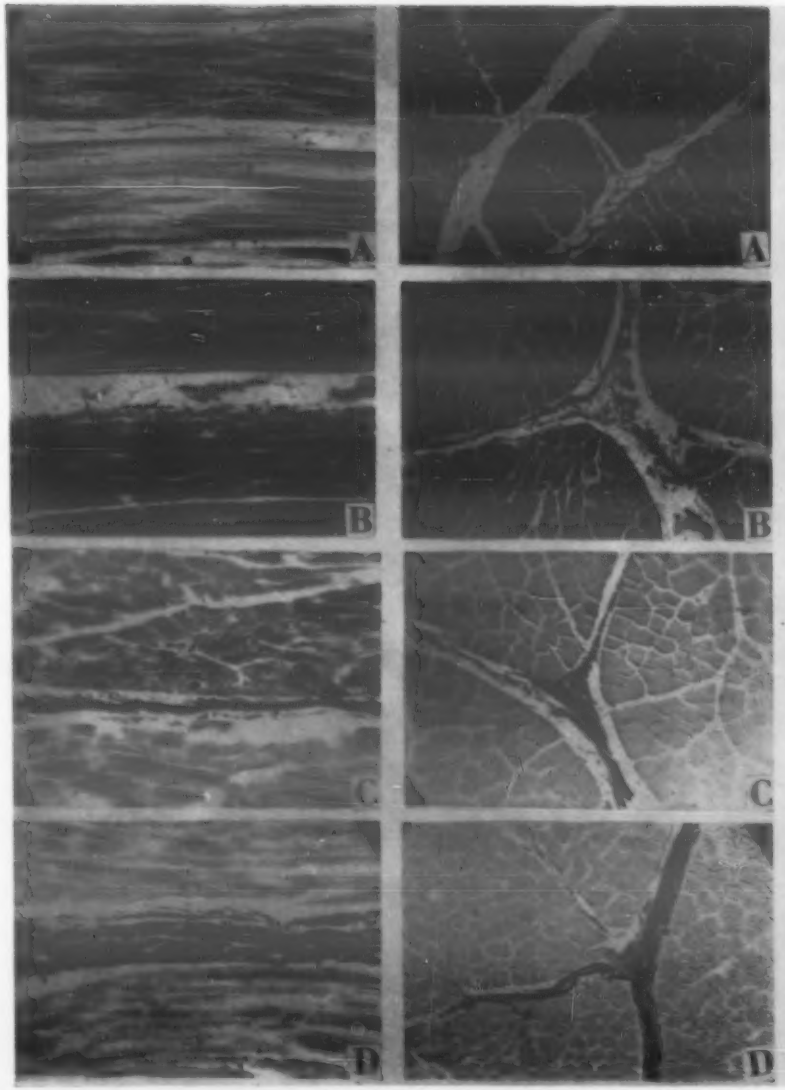


Figure 5. Photomicrographs of representative longitudinal sections (on left) and cross-sections (on right) of beef muscles from a 500-pound steer calf stained with triple stain to differentiate collagenous and elastic fibers: A, psoas major (tenderloin); B, longissimus dorsi (short loin); C, semimembranosus (round); D, serratus ventralis (neck). (240 ×)

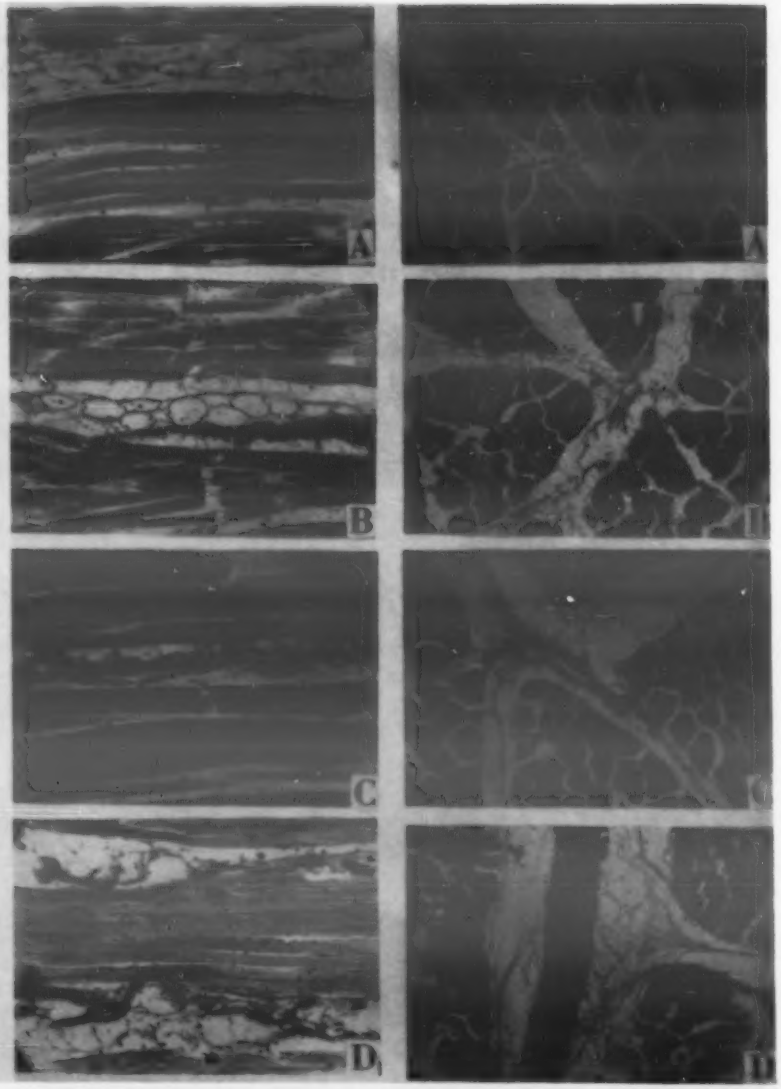


Figure 6. Photomicrographs of representative longitudinal (on left) and cross-sections (on right) of beef muscles from a barren heifer stained with triple stain to differentiate collagenous and elastic fibers: A, psoas major (tenderloin); B, longissimus dorsi (chuck, third rib); C, semitendinosus (round); D, serratus ventralis (neck). (240 ×)

are representative of the sections and of the age groups. The cross-section ones were from the same muscle as the longitudinal ones. The sections were selected on the basis of 4 degrees of tenderness with one photomicrograph representing each. A study of these photomicrographs of triple staining confirm the results found with orcein and aniline blue staining.

## SUMMARY AND CONCLUSION

Studies were made to determine the relationship to tenderness of the amount and character of collagenous and elastic fibers in beef muscle that varied widely in tenderness. Nine samples of beef muscle from each of 52 animals varying in age from ten-week-old veal calves to nine-year-old cows were used. After removing histological sections, the samples were weighed, heated to an internal temperature of 60° C. (140° F.) and tested objectively for tenderness.

Histological study of the muscle samples showed that elastic fibers could be classified with respect to size, distribution, and frequency. The rating of elastic fibers indicated that those present in the muscles which were used most, such as the *serratus ventralis*, deep digital flexor, *semimembranosus, semitendonosus* and *biceps femoris*, were more numerous and larger than in the muscles which were not used so extensively, such as the *psoas major* and *gluteus medius*.

**TABLE 1**

**Histological ratings[1] of elastic tissue according to size, distribution and frequency by age groups[2]**

| Muscle | Veal calves | Steer calves, 500 lbs. | Steers 900 lbs. | Heifers barren | Cows |
|---|---|---|---|---|---|
| Number of animals | 3 | 8 | 25 | 8 | 8 |
| Age—months | 2.5 | 8 | 14 | 37 | 67 |
| *Serratus ventralis* | 10 | 11 | 12 | 14 | 14 |
| Deep digital flexor | 11 | 12 | 14 | 15 | 15 |
| *Longissimus dorsi*—3rd rib | 7 | 7 | 8 | 9 | 10 |
| *Triceps brachii* | 7 | 8 | 8 | 10 | 10 |
| *Longissimus dorsi*—8th rib | 5 | 7 | 8 | 8 | 10 |
| *Longissimus dorsi*—shortloin | 6 | 7 | 7 | 8 | 11 |
| *Psoas major* | 3 | 3 | 4 | 5 | 6 |
| *Gluteus medius* | 6 | 7 | 8 | 7 | 9 |
| *Semimembranosus* | 7 | 8 | 10 | 12 | 13 |
| *Semitendinosus* | 7 | 8 | 11 | 12 | 13 |
| *Biceps femoris* | 7 | 7 | 10 | 12 | 12 |

[1] Description of factors:

Size: 1—*very narrow*, 2—*narrow*, 3—*moderately wide*, 4—*wide*, and 5—*very wide*.

Distribution: 1—*very scattered*, 2—*scattered*, 3—*tending to form groups*, 4—*recognizable groups*, and 5—*grouped*.

Frequency: 1—*small number* (can count), 2—*more numerous* (cannot count), 3—*very numerous*, 4—*abundant*, and 5—*very abundant*.

[2] The sum of size, distribution, and frequency is the total score.

The studies showed that those muscles which were used more extensively by the animal had larger amounts of collagenous fibers, whereas, those with less activity had smaller amounts. In muscles where fatty deposits were evident, the collagenous fibers formed more of a loose network between muscle bundles; in those with less fat they appeared bunched.

On the basis of the available data, the general conclusions from this study indicate that collagenous and elastic fibers are factors influencing tenderness. Their means of affecting tenderness are rather obscure and warrant further study. From this study and previous work, it is emphasized that tenderness in beef is a function of many interrelated factors, namely; breeding, feeding, management, age, period of aging the raw meat, presence of collagenous and elastic fibers, size of fibers, the method of cooking the meat and probably many others. Because of their interrelationships, an increase in our knowledge and control of any one of these factors alone will not necessarily result in tender meat.

## LITERATURE CITED

1. Bradley, H. C. Autolysis and Atrophy. *Physiol. Rev.*, **18**, 173 (1938).
2. Deatherage, F. E., and Reiman, W. Measurement of beef tenderness and tenderization of beef by Tenderay process. *Food Research*, **11**, 525-534 (1946).
3. Golovkine, N. A., Zelentsov, E. F., Smirnov, A. P., and Shkolinikova, E. F. Quality indices for cooled meat. Trav. de l'Inst. Mec-Tech. de l'Ind. Frig. de Leningrad, **2**, 175-194 (1939). *Bull. Intern. Inst. Refrig.*, **20** (1), 64 (Abst.) (1939).
4. Hiner, R. L., and Hankins, O. G. The tenderness of beef in relation to different muscles and ages in the animal. *J. Animal Sci.*, **9**, 347-353 (1950).
5. Hiner, R. L., Hankins, O. G., Sloane, H. S., Fellers, C. R., and Anderson, E. E. Fiber diameter in relation to tenderness of beef muscle. *Food Research*, **18**, 4, 364-376 (1953).
6. Hoagland, R., McBryde, C. N., and Powick, W. C. Changes in fresh beef during cold storage above freezing. U. S. Dept. Agric. *Bull. 433*, 100 (1917).
7. Husaini, S. A., Deatherage, F. E., and Kunkle, L. E. Studies on meat II. Observations on relation of biochemical factors to changes in tenderness. *Food Technol.*, **4**, 366-369 (1950).
8. Husaini, S. A., Deatherage, F. E., Kunkle, L. E., and Draudt, N. H. Studies on meat I. The biochemistry of beef as related to tenderness. *Food Technol.*, **4**, 313-316 (1950).
9. Lee, B. *Microtomist's Vade-Mecum*. 1928, P. Blakiston's Son & Co., Philadelphia, Pa.
10. Mackintosh, D. L., Hall, J. L., and Vail, G. E. Some observations pertaining to tenderness of meat. *Proc. 29th Annual Meeting Am. Soc. Animal Prod.*, 285-289 (1936).
11. Mallory, F. B. The aniline blue collagen stain. *Stain Technol.*, **11**, 101-102 (1936).
12. Mallory, F. B. *Pathological Technique*. 1938, reprinted 1944. W. B. Saunders Co., Philadelphia, Pa.
13. Maximow, A. A., and Bloom, W. *A Text Book of Histology*. 1930, W. B. Saunders Co., Philadelphia and London.
14. Mayer, P. *Mitt. Zool. Stat. Neapel*, **10**, 170-186 (1891). (Original not seen; quoted by Mallory, *25*).
15. Mitchell, H. H., Hamilton, T. S., and Haines, W. T. Some factors affecting the connective tissue content of beef muscle. *J. Nutrition*, **1**, 165-178 (1928).
16. Mitchell, H. H., and Hamilton, T. S. Effect of long-continued muscular exercise upon the chemical composition of the muscles and other tissue of beef cattle. *J. Agr. Research*, **46**, 917-941 (1933).
17. Mitchell, H. H., Hamilton, T. S., and Bull, S. 46th Ann. Rept., 1933, Illinois Agr. Exp. Sta. p. 77. Abstract Report of Review Committee, Conference on Cooperative Meat Investigations, **1**, 1937.
18. Moran, T., and Smith, E. C. Post mortem changes in animal tissue, the conditioning or ripening of beef. (Brit.) Food Invest. Bd. Special Rept. No. 36. (1929), H. M. Stationery Office, London.
19. Ramsbottom, J. M., Strandine, E. J., and Koonz, C. H. Comparative tenderness of representative beef muscles. *Food Research*, **10**, 497-509 (1945).
20. Smorodintsev, I. A., and Nickolaeva, N. V. Modification of Cathepsin during the autolysis of muscular tissue. *Compt. Rend. Acad. Sci., U. R. S. S.*, **3**, 375 (1936). *Chem. Abstr.*, **31**, 720.
21. Smorodintsev, I. A., and Nickolaeva, N. V. Changes in activity of peptidase on autolysis of muscular tissue. *Compt. Rend. Acad. Sci., U. R. S. S.*, **34**, 233-234 (1942). *Chem. Abstr.*, **37**, 2833.
22. Steiner, G. The post mortem changes in beef muscle at various temperatures. *Arch. Hyg. Bakt.*, **121**, 193-208 (1939). *Chem. Abstr.*, **33**, 2965.
23. Unna, P. G. Notiz. betreffend die Taenzersche Orceinfurbung des elastischen Gewebee. Monatsh. f. prakt. Dermat., **12**, 394-396 (1891). (Original not seen; quoted by Mallory, *25*).
24. Van Gieson, I. Laboratory notes of technical methods for the nervous system. New York Med. J., **50**, 57-60 (1889).
25. Verhoeff, F. H. Some new staining methods of wide applicability; including a rapid differential stain for elastic tissue. *J. Am. Med. Assoc.*, **50**, 876-877 (1908).
26. Weigert, C. Teber eine methods zur Furbung elastischer Fasern. Zentra. f. allg. Path. u. path. *Anat.*, **9**, 289-292 (1898). (Original not seen; quoted by Mallory, *25*).

# A Laboratory Fruit-Essence Recovery Unit

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(Manuscript received July 17, 1954)

**Design and operation of a small but effective laboratory essence recovery unit are described. The unit has been useful in examining volatile flavor components in fruit juices and in determining degrees of evaporation suitable for recovery of their components from various fruit juices.**

The first successful method for recovery of natural volatile flavors from fruit juices was proposed by Milleville and Eskew *(4)*. The method was contingent upon three properties of such juices: (a) that a major portion of volatile flavors usually can be removed by evaporation of 10 to 30% of the water in a juice, (b) that the volatile flavors are sufficiently heat-stable to permit concentration in a partial reflux system at atmospheric pressure, and (c) that fruit juices can be subjected to temperatures of 212° F. (100° C.) or above for a few seconds without production of discernible changes in color or flavor.

The trend toward storage and merchandising of fruit juices and purees in concentrated form has stimulated interest in commercial essence-recovery systems as concentrated juices contain little, if any, of the volatile constituents originally present unless recovered flavors have been incorporated with the product after concentration. Because flavor components of fruits vary widely in ease of removal, laboratory studies usually are needed prior to purchase of one of several available commercial units. Such preliminary studies follow the general pattern of determining (a) whether recoverable volatile flavors are present in a particular material, (b) if so, the degree of evaporation needed for recovery of a major portion of the volatile constituents, and (c) the sensitivity of the material to damage by heat.

This paper describes a relatively inexpensive laboratory unit which has proved to be a handy tool for such studies. Although its design capacity is small (400 ml./min.) in comparison to that of production-size units, results have correlated well *(7)* with those obtained in commercial units equipped with either a tubular *(4)* or a steam-injection *(2)* type of preheater. The unit has been used during the past five years to obtain data on essence recovery from several fruit juices and purees, including apple juice *(6)*, Italian prune juice *(8)*, and strawberry juice *(7)*.

In the design of the unit, velocity in the preheater and vaporizer sections was made sufficiently high to avoid "burn on" of material passing through. All parts except the pumping, preheating, and vaporizing sections are of glass, permitting visual observation of material in important sections of the unit. These points include liquid levels in the essence take-off assembly and in the reboiler, and the possible presence of distillable wax in the material. Scrubbing of vent gases was found to be unnecessary when concentrated essences were cooled to 32° to 36° F. (0° to 2.2° C.) in the cooling coil and held within these temperature limits in the collection flask. The quantity of non-condensed gases passing from the take-off assembly vent to the cold collection flask was found to be too small to cause a detectable loss of essence from the system.

## DESCRIPTION OF UNIT

The essence stripping section consists of an arrangement for supplying juice at a controlled rate, a preheating tube for heating juice to boiling temperature at a vary rapid rate, a vaporizing tube for evaporating the desired percentage of water and a cooling coil for rapid cooling of stripped juice. The unit (Figure 1) has a water supply flask *(A)* and a feed flask *(B)*, connected through a three-way stopcock *(C)* to a gear pump *(E)*. The gear pump is driven by a variable-speed transmission *(D)* which permits positive control of the feed rate over a wide range of pumping speeds. The preheating tube *(F)* is designed to provide a liquid residence time in the jacketed zone of one second at the design feed rate. When operated at a pressure 12 p.s.i.g. of steam in the jacket, vapor is formed in the tube several inches short of the end and a mixture of liquid and vapor blasts out of the tube at a considerable velocity. The vaporizer section *(G)* serves to evaporate the desired quantity of water and is designed to maintain the liquid-vapor mixture passing through it in a turbulent state. Jacket steam pressures in the preheating and vaporizing tubes may be controlled either by pressure gages connected to, or thermometers inserted into, steam lines in close proximity to the tubes. The condenser system *(W)* for cooling stripped juice should be sufficiently effective to cool to within a few degrees of room temperature. The stopcock *(X)* is used to hold the level of stripped juice above the top of the condenser jacket. The sample tube *(Y)* is used to obtain samples for refractometer measurements.

The essence concentration system consists of a packed fractionating column, a condenser system which returns essence-enriched condensate to the top of the column, a reboiler which maintains the column in operation and an arrangement for continuous removal of concentrated essence from the system. The column *(I)* is filled with 0.5-inch cylinders cut from 12 mm. glass tubing which are supported by a stainless-steel screen *(J)*. The type of reflux return line built into the head of the column is needed to preclude flooding of the column. The vent cock *(K)* serves as a vent for removal of entrapped air when the equipment is boiled out prior to starting a run. The coil in the condenser *(L)* (8-mm. tubing) is large enough in diameter to eliminate capillary blocking of the tube. Fourteen turns in the coil provide sufficient cooling area to result in condensate temperatures very close to that of the condensing water. The reboiler *(S)* serves as a source of water vapor to maintain the column in operation. The overflow *(T)* of the reboiler serves to remove condensed water. Rubber tubing connected to it should be made adjustable in height in order to maintain a constant liquid level in the reboiler at all times, regardless of the degree of evaporation employed. A rheostat *(U)* is used to vary the power supplied to the nichrome coil *(V)* in the reboiler. Standard taper spherical (ball-and-socket) joints are used to permit rapid alignment during assembly and for connection of glass and stainless-steel components.

Particular attention should be paid to construction details of the essence take-off assembly *(M)* and of the U-tube *(N)* in the reflux return line. As the return of cold reflux causes condensation of vapor in the upper part of the column, the reflux must

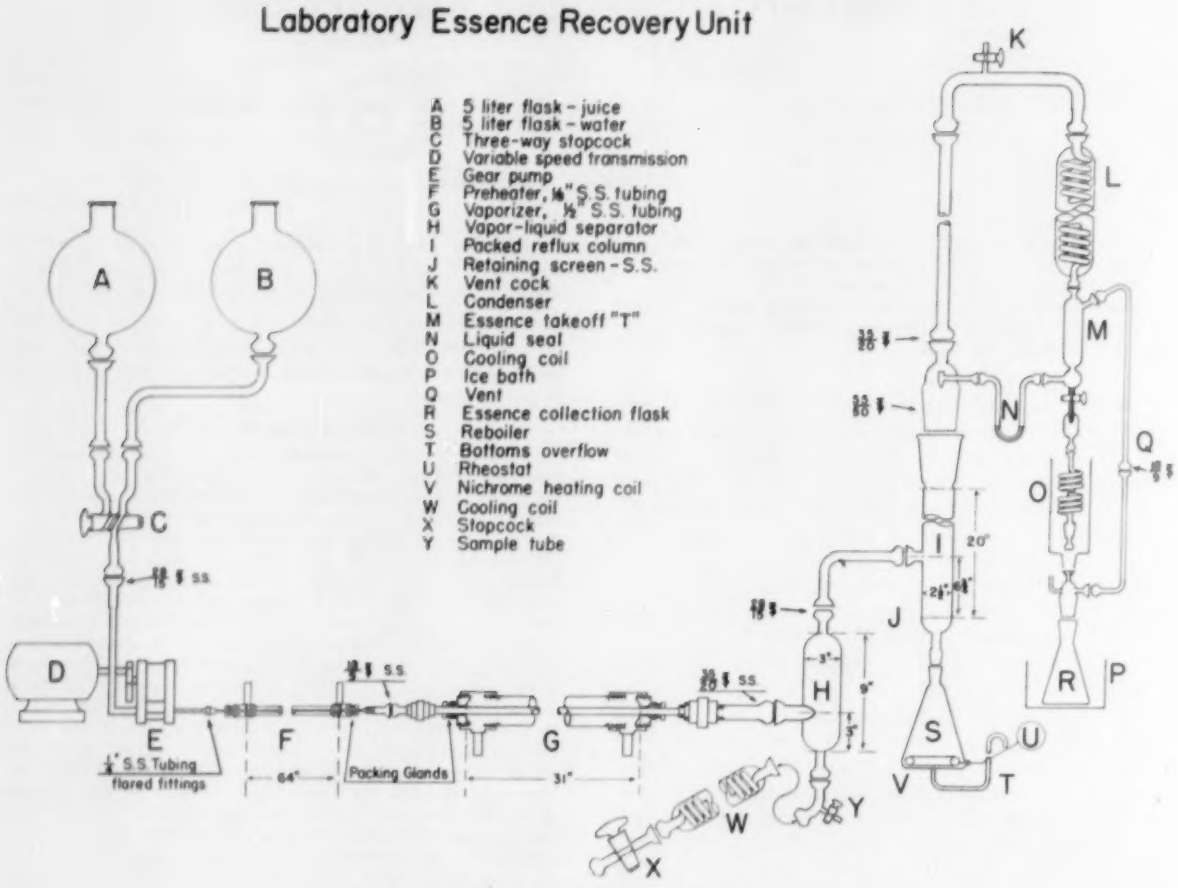


**Figure 1. Laboratory essence recovery unit.**

be returned at a uniform rate to avoid erratic condensation which will, in turn, cause surging and periodic flooding of the column. The dual-bulb design in *M*, the 1-mm. capillary section in *N* and the return line outlet in *I* are designed to control the reflux return rate adequately to prevent erratic operation. The U-tube *(N)* serves as a liquid seal to prevent hot vapors from entering the essence take-off assembly. A 1-mm. stopcock, rather than a metering pump, is used for removal of concentrated essence due to the small rate of flow (4 ml./min. or about 1 drop/sec. to recover 100-fold essence). Both the jacket assembly surrounding the cooling coil *(O)* and the ice bath *(P)* are needed to cool and hold concentrated essence at near freezing temperatures in order to prevent serious loss of the highly volatile product. The vent *(Q)*, connecting the take-off assembly M with the collection flask *(R)*, is needed for removal of gases dissolved in the feed.

## METHOD OF OPERATION

A flow of water is started by the gear pump, and the reboiler is filled before heat is applied. With condensers left empty, steam in tube jackets and power to the reboiler coil are turned on. The unit is operated until no odors can be detected in steam emanating from vents *K* or *P*. Vent *K* is closed and condensers are turned on. When the unit is operating smoothly, ice is placed in the jackets of the essence-cooling coil *O* and collection flask *R*, and Stopcock *C* is set to supply juice or puree to the unit.

Steam pressure on the vaporizer jacket is adjusted to the desired pressure and the level of the stripped juice is adjusted to a point slightly above the top of the jacket of condenser *H*. Maintenance of the liquid level above this point results in excessive exposure of stripped product to heat, while maintenance below this point may result in condensation of some essence-containing vapor. The stopcock on the take-off assembly *M* is opened after a few minutes and adjusted to the desired rate of flow.

A certain period of operating time is required before the system reaches equilibrium. The length of this period is dependent upon both the juice feed rate used and the degree of essence concentration desired. For collection of 100-fold (by volume) concentrated essence at the design feed rate, the delay needed is approximately 7 minutes. For collection at other concentrations or feed rates, the time needed to reach equilibrium may be determined either on the basis of refractive-index values obtained in a differential refractometer *(1)* or by analysis of total carbons *(3)*.

Both the percentage of evaporation of material and the degree of concentration of volatile flavors are usually expressed on a volume basis, because control devices used in commercial units such as metering pumps and flow meters measure the volume rather than the weight of material passing through them. The percentage of evaporation by volume can be computed from the soluble solids concentrations in original and stripped material as measured on a refractometer [readings corrected to 68° F. (20° C.)] by use of the following relationship:

$$E_v = 100\ G_1 \left( \frac{S_2 - S_1}{S_2} \right)$$

where $E_v$ = volume percentage of material being evaporated; $G_1$ = specic gravity of original material at 68° F. (20° C.); $S_1$ = weight percentage of soluble solids in original material;

and $S_2$ = weight percentage of soluble solids in stripped material. In deriving the formula, it was assumed that the temperature of the feed was 68° F. (20° C.). The formula is applicable within the ordinary range of feed temperatures (40° to 100° F.), for the error in $E_v$ induced by changes in volume-weight relationships is of the order of ±0.2%.

If it is desired to conduct experiments on a weight basis, the percentage of material evaporated, $E_w$, can be computed from:

$$E_w = 100\left(\frac{S_2 - S_1}{S_2}\right)$$

Table 1 records information obtained during recovery of volatile flavors from a sample of strawberry juice and serves as a convenient record form.

**TABLE 1**

**Data sheet. Laboratory essence recovery unit.**

| Material | Date |
|---|---|
| Strawberry juice | April 2, 1954 |

Steam settings:
Preheater: 13 lb./in.²
Vaporizer: 7 lbs./in.²

Time data:
Feed; finish: 11:24
Feed; start: 9:24
Feed; total (T): 120 min.

Reboiler rheostat setting: 50

Essence; finish: 11:24
Essence; start: 9:30
Essence; total ($T_2$): 114 min.

Feed rates:
Water: 410 ml./min.

$$\text{Juice } (J_f) = \frac{J_1}{T_1} = \frac{4800}{120} = 400 \text{ ml./min.}$$

Juice in 49450 g. = ($J_1$) 48,000 ml. @ ($S_1$) 8.0° Brix

Strip out 44050 g. = 42,580 ml. @ ($S_2$) 9.0° Brix

Essence out (V) 420 g.

Specific gravity of juice ($G_1$) 1.0299

Percent evaporation (by volume):

$$E_v = 100\ G\left(\frac{S_2 - S_1}{S_2}\right) = 100\ 1.0299\left(\frac{9.0\text{-}8.0}{9.0}\right) = 11.1\%$$

Fold essence:

$$X = \frac{J_1 - J_f\ (T_1 - T_2)}{V} = \frac{48000 - 400\ (114 - 120)}{420} = 108.5 \text{ fold}$$

## OTHER APPLICATIONS

The preheater portion of the unit has been found useful for hot packing of material such as non-citrus fruit juice and juice concentrates into small cans (6-ounce or baby food). For this purpose, a glass elbow containing a thermometer is connected to the ball joint at the outlet end of the tube. Steam pressure in the jacket is adjusted to heat the material to the desired filling temperature. Filled cans are sealed, inverted for 2 minutes and placed in cold running water. The chief advantage in use of the tube for this purpose lies in the short "come-up" time needed to heat the material, which eliminates or greatly minimizes damage to color and flavor resulting from excessive holding times at elevated temperatures.

The preheater has been used for determination of enzyme inactivation rates in liqueform fruit products *(5)*. To accomplish this, a holding coil is used to connect the preheater tube outlet with an efficient cooling coil. The holding coil is immersed in a constant-temperature bath similar in design to that surrounding coil *O*. Holding periods may be changed by using tubes of different lengths. Product temperatures as low as 170° F. have been obtained by use of steam-air mixtures in the jacket of the preheater. Further lowering of temperature may be obtained by use of sub-atmospheric steam. The short "come up" time permits study of reactions occurring after a material has reached a desired temperature, provided holding times are chosen which render negligible the time consumed in raising the temperature to the desired level. By this means, the time required to inactivate an enzyme at each of several temperatures, and the rate of inactivation at a given temperature may be determined. Likewise, the relation between time-at-temperature and the development of heat-induced types of off-flavors may be determined.

## LITERATURE CITED


1. Brice, B. A., and Speiser, R. A differential refractometer. *J. Opt. Soc. Am.*, **36**, 363 (1946).
2. Brown, A. H., Lazar, M. E., Wasserman, T., Smith, G. S., and Cole, M. W. Rapid heat processing of fluid foods by steam injection. *Ind. Eng. Chem.*, **43**, 2949 (1951).
3. Christensen, B. E., Wong, R., and Facer, F. J. Determination of the carbon content of organic materials. *Ind. Eng. Chem., Anal. Ed.*, **12**, 364 (1940).
4. Milleville, H. P., and Eskew, R. K. Recovery and utilization of natural apple flavors. *AIC-63* (Mimeo.), Bureau of Agr. and Indus. Chem., U. S. Department of Agriculture (April, 1945).
5. Ponting, J. D., Bean, R. S., Notter, G. K., and Makower, B. Degree of heat-inactivation of polyphenol oxidase and quality of frozen apricot puree. *Food Technol.*, **8**, 573 (1954).
6. Walker, L. H., Nimmo, C. C., and Patterson, D. C. Preparation of a frozen apple juice concentrate. *Food Technol.*, **5**, 148 (1951).
7. Walker, L. H., Notter, G. K., McCready, R. M., and Patterson, D. C. Concentration of strawberry juice. *Food Technol.*, **8**, 350 (1954).
8. Walker, L. H., and Patterson, D. C. Preparation of fresh Italian prune juice concentrates. *Food Technol.*, **8**, 208 (1954).

# Consumer Wine-Preference Methodology Studies at California Fairs

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(Manuscript received July 12, 1954)

**For 3 years consumer reaction to several types of wine and to variations in wine composition has been observed by means of samples and questionnaires presented to thousands of visitors to two large California Fairs. Although much incidental knowledge has been gained about consumer preferences in wines, the main purpose of the experiment has been to investigate the methodology of this type of consumer survey, to learn how to interpret the data obtained, and to ascertain its reproducibility. Several modifications in design of the experiment, type of questionnaire, and method of scoring have been tried. Some interesting data have been obtained indicating biases for the middle sample in the triangular test and for the first sample in the paired comparison test.**

For three successive years, starting in 1951, consumer reaction to several types of wine and factors in wine composition has been studied at California Fairs. The ultimate goal is to assess consumer response to wines, with the hope that such information will enable the prediction of the success of a wine before it is marketed and aid in the creation of more popular wines. Our initial concern, however, has been to develop effective, practical methods to carry out such surveys, and to check their reproducibility. To this end several different experimental designs, questionnaires, and scoring methods have been tried.

## TEST PROCEDURES AND RESULTS

**The 1951 survey.** In 1951, the first year of the survey, at the California State Fair, 3049 visitors participated in what was essentially a ranking test for preference. Each participant was served 3 samples of wine of the same general type, but different primarily in sweetness. These were either a dry, a medium, and a sweet Sherry; a dry, medium, and sweet Sauterne; or a rosé, a Burgundy, and a sweetened red table wine. They were presented in order of increasing sweetness and the taster was asked to indicate his first and second choices. The wine type served was rotated, only one group of three being presented on any one day.

The rather complex questionnaire which accompanied the samples required the judge to check his age group (21 to 35; 35 to 50; or over 50), sex, his category with respect to frequency of wine use (several times weekly or daily, several times per month, or a few times a year or never), and his marital status, as well as to indicate his national origin, and the type of wine (if any) he ordinarily consumed.

The data collected (Table 1) indicated preference in general for the sweeter samples, and this choice was significant at the 5% level (when tested by the chi-square hypothesis) for some but not all groups of tasters. It is also notable that the second sample in each group was invariably preferred by the fewest people, though it is not clear from this experiment whether this result is due to the sweetness factor, the quality of the particular wines used, or to the order of serving.

The tendency to prefer the sweeter wines seemed to be greater among women than among men, and among infrequent wine users than among frequent consumers. The proportion of judges preferring the sweetest sample in each set increased regularly with age for both males and females.

This first year's survey contained quite a few obvious faults. In the first place, although the 3 wines in each group were of the same general type and usually were all obtained from the same winery, they differed in characteristics other than sugar concentration. There is no way of knowing how important these other factors were in influencing the outcome. We assumed that the particular wines selected were representative of their type. Since order of presentation and tasting was not randomized, biases due to position could not be prevented or even estimated. Finally, the questionnaire used proved to be too lengthy and complicated, and tended to confuse or discourage many of the participants.

**The 1952 survey.** The following year, the questionnaire was modified, and the wines presented as paired comparisons. A large number of fair visitors participated, 7482 persons taking part in the survey. The following information was required on the questionnaire: age group, sex, marital status, the geographical region (state) in which the participant lived, frequency of use of wine, whether or not the participant used grape juice, and how well he liked grape juice. The latter 2 questions were asked because most of the wine served in 1952 was of the sweetened Concord type, and it was thought that an acquaintance with, or liking for, the typical Concord flavor of grape juice might influence the acceptance of this kind of wine. Subsequent analysis of the data did not suggest any appreciable correlation between these factors.

**TABLE 1**

**Summary of consumer response at the 1951 California State Fair**

| Wine type | Preference for [1] | | | | Dual preference or no preference | |
|---|---|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | | | |
| Red Table Wines | 276 | 183 | 536* | 995 | 184 | 1179 |
| Sauternes | 306 | 172 | 567* | 1045 | 164 | 1209 |
| Sherries | 245 | 81 | 265 | 591 | 70 | 661 |
| | | | | 2631 | | 3049 |

[1] In each category, No. 1 is the driest wine, No. 3 the sweetest. Thus:
No. 1—rosé wine, dry sauterne, dry sherry.
No. 2—Burgundy, medium Sauterne, medium Sherry.
No. 3—slightly sweetened red table wine, sweet Sauterne, cream Sherry.
* Preference significant at 5% level.

After tasting the samples the judge was asked which sample he liked better (if he could decide), and how much better he thought it tasted *(slightly better, moderately better,* or *very much better)*. Space was left for comments.

The order of presentation of the samples was reversed every 2 hours during the day, and whenever possible, only one pair of wines was served on a given day. No influence of time of day on preference response was found other than that ascribable to order of presentation of sample. When the same set of wines was served on 2 different days, no significant difference in preference was found from one day to another.

The wines studied fell into two categories: Concord wines from California and the Eastern United States, served still and

carbonated; and Port wines of 18 and 20% alcohol content (actually derived from a single 19% wine, part of which was diluted with water to 18% alcohol content, and part of which was diluted with neutral, triple-distilled brandy and water to 20% alcohol content). Part of each of the 3 lots of still Concord wines (2 typical California Concord brands and the Eastern Concord judged best of a group of 6 or 7 by a panel of experts) was carbonated to about 0.85 atm. at 12° C. Eight different paired comparisons were made, encompassing choices between Eastern *vs.* California wines, identical wines served carbonated and still, carbonated Eastern Concord *vs.* still California Concord, and *vice versa*.

The data obtained on the Concord wines indicated no appreciable choice between the Eastern and Western Concords. Slightly carbonated wines were always preferred, though never by a very wide margin, to still wines. Except for a very slight tendency for carbonation to be appreciated more by women and by people in the youngest age group (21-35), there was no appreciable difference in response based upon age, sex, or frequency of wine use.

With 1176 tasters, the preference of 581 for the 18% Port sample (446 preferred the 20%, 149 were undecided) was statistically significant at a probability level of less than 0.1%. The preference for the less alcoholic sample was exhibited by all groups, though it was slightly less significant among men than women, and decreased rather markedly with increasing age, and with increasing frequency of use of wine.

Again in this survey, although the desired preference information was obtained, the questionnaire proved rather unwieldy. It was indicated that some changes should be made in order to minimize confusion and yet derive as much useful information as possible.

**The 1953 survey.** In 1953 the questionnaire for paired comparisons employed two hedonic scales *(3)* to compare the wines; on each the degree of liking or disliking of a sample could be indicated by checking one of 9 steps, ranging from *like extremely* down to *dislike extremely*. In this way the 2 wines could be compared directly in the standard language furnished by the scale. The personal questions asked were reduced to age group, sex, and frequency of use of wine; others included in previous years had been found to be irrelevant (showed no correlation with acceptability) or inapplicable to our situation. (For example, in the first 2 years we had discovered the fraction of participants from states other than California to be very small.) A line at the bottom of the questionnaire was allotted for comments. In this way, only 5 check marks were necessary to furnish the information needed, plus a few words for comments, if the participant was so inclined. The method was simple, rapid, and economical. Furthermore, the data from the questionnaires could be transferred conveniently to I.B.M. cards for subsequent tabulation and analysis, as was done with the information from the 1952 and 1953 surveys.

At 2 fairs, one the California State Fair in Sacramento, the other the County Fair in Fresno, a total of 16,330 persons participated in the 1953 survey. With an attendance of slightly over 1,000,000 in all at the two fairs this would reflect a cross-section of 1.6%, a fair-sized sample.

Three pairs of wines were compared at each of the 2 fairs, and in addition, a single wine sample of an unusual type was presented by itself for consumer reaction. The pairs included a dry red table wine (0.2% reducing sugar) and the same wine slightly sweetened (1.4% reducing sugar); a Port wine with a lower than usual total acid content (0.4%, calculated as tartaric acid), and the same wine acidified with tartaric acid to the 'usual' (0.5%) acid content; and the same 18 and 20% alcohol Port wines that were served in 1952. As a further check on reproducibility of results and the effect of different tasting designs, the latter two Port wines were also compared in a triangular design *(1)* during one entire day at the Sacramento Fair only.

The hedonic scale was translated later into numerical values from 1 to 9 for statistical analysis, the latter value being assigned to the highest degree of liking. The equal weighting was selected arbitrarily, since there was no experimental information on which to base a more accurately weighted scale. It was found that, in general, the participants tended to be somewhat generous in their scoring, not much use being made of the lower half of the scale. Possibly a scale of fewer steps, with a larger proportion of the scores in the positive range than in the negative range, would be more suitable to differentiate the degrees of liking.

Briefly, the data obtained, when analyzed with the aid of I. B. M. equipment, indicated a consistent, and statistically very highly significant preference for the sweetened red table wine, no significant difference between the Ports of different total acidity, and a slight preference for the 18% of the 20% Port wine (Table 2). Much additional information of value and interest was obtained by analysis of the responses within specific groups (by age, sex, etc.).

### Bias Shown by Survey Groups

Of at least as great an interest to us as these practical results was the information gained about the methodology of consumer surveys. One of the most striking features was the strong bias exhibited by tasters for the first sample in paired comparisons, and for the second sample in the triangular design. In the 1953 survey this bias in preference for the first sample in paired comparisons was shown for all wine comparisons made.

**TABLE 2**

**Summary of consumer response at 1953 California fairs using paired comparisons and hedonic scale**

| | Red Table Wines | | | Port Wines | | | Port Wines | | | Sparkling Muscat | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of participants | Average scores | | No. of participants | Average scores | | No. of participants | Average scores | | No. of participants | Average score |
| | | 0.2% Sugar | 1.4% Sugar | | 0.4% Acid | 0.5% Acid | | 18% Alcohol | 20% Alcohol | | |
| All Participants | 3775 | 6.6 | 7.3*** | 3266 | 7.2 | 7.2 | 3173 | 7.3 | 7.1** | 4498 | 7.9 |
| Age Classification: | | | | | | | | | | | |
| 21–35 | 2019 | 6.4 | 7.3*** | 1633 | 7.0 | 7.0 | 1386 | 7.1 | 6.8** | 2238 | 7.8 |
| 35–50 | 1131 | 6.8 | 7.4*** | 1056 | 7.3 | 7.3 | 1056 | 7.3 | 7.3 | 1432 | 7.9 |
| Over 50 | 541 | 6.8 | 7.6*** | 508 | 7.6 | 7.7 | 645 | 7.7 | 7.5* | 719 | 8.1 |
| Males | 2041 | 6.6 | 7.1*** | 1700 | 7.2 | 7.2 | 1575 | 7.2 | 7.1 | 2378 | 7.8 |
| Frequency Classification: | | | | | | | | | | | |
| Several times per week | 656 | 6.8 | 7.4*** | 545 | 7.4 | 7.4 | 514 | 7.4 | 7.3 | 778 | 7.8 |
| Few times per month | 996 | 6.6 | 7.2*** | 784 | 7.1 | 7.2 | 756 | 7.2 | 7.1 | 1118 | 7.8 |
| Few times per year or never | 389 | 6.1 | 6.6*** | 330 | 6.8 | 6.9 | 305 | 7.0 | 6.8 | 436 | 7.7 |
| Females | 1406 | 6.5 | 7.2*** | 1266 | 7.2 | 7.2 | 1207 | 7.3 | 7.1* | 1746 | 8.1 |
| Frequency Classification: | | | | | | | | | | | |
| Several times per week | 373 | 6.9 | 7.4*** | 310 | 7.3 | 7.5 | 314 | 7.5 | 7.4 | 396 | 8.1 |
| Few times per month | 632 | 6.6 | 7.4*** | 551 | 7.3 | 7.3 | 546 | 7.4 | 7.2 | 838 | 8.0 |
| Few times per year or never | 401 | 6.1 | 6.7*** | 369 | 6.8 | 7.0 | 347 | 7.0 | 6.6* | 478 | 8.0 |

* Difference between average scores for the two wines statistically significant (5% level).
** Difference between average scores for the two wines highly significant (1% level).
*** Difference between average scores for the two wines very significant (0.1% level).

At one session, 2 identical samples of wine were presented. Of 899 participants, 381 expressed a preference for sample No. 1, 256 for sample No. 2, with the remaining 262 scoring the two samples identically. At another session, when the 2 red table wines were presented, one dry and the other slightly sweetened, the sweeter wine was decidedly preferred over the dry regardless of order of presentation. However, when the sweeter wine was served first it was scored higher by 1623 persons, against 368 who preferred the dry wine. When the dry wine was served first, there were only 999 who preferred the sweeter wine against 435 for the dry wine. A similar bias was observed throughout the survey. (For example, note the effect of order of serving on the preference data for 18% *vs.* 20% Port wine in Table 3.) The 1952 data also clearly indicated this bias.

The bias for the middle sample in the triangular test has been noted previously by Harrison and Elder *(2)*. The comparison of the Port wines of different alcohol content, using the triangular design, at the 1953 Sacramento Fair clearly demonstrated this bias. All 6 possible arrangements were presented an approximately equal number of times; there were 713 triangular tests in all. On a purely chance basis one would expect each of the 3 positions to be selected as odd an equal number of times. However, a choice of the second sample as the odd sample occurred 44% of the time, against 25% for the first sample and 31% for the third sample.

In this connection, studies for threshold determinations in our laboratories, using triangular tests with small trained panels, illustrated a similar bias. Of 2154 judgments over a period of 6 months, 781 (36.2%) of the choices were for the middle sample as odd, a number that is statistically highly significant.

### Reproducibility of Survey Results

As stated previously, the paired comparisons showed in 1952, with 1176 persons tasting the 2 wines, that there was a statistically significant preference for the 18% wine over the 20%. In 1953, using the hedonic scoring, and with 3063 participants, a preference, although slight, was again found for the 18% wine. The average hedonic rating of the 18% wine was 7.3, against 7.1 for the 20% Port. Agreement between average scores at the Fresno and Sacramento Fairs was fairly good. The mean hedonic ratings at the former were 7.2 and 6.9 for the 18% and 20% wines, respectively, as compared with 7.4 and 7.2 at Sacramento. The lower alcohol wine was given a higher score 1352 times, the higher alcohol 1093 times, while the remaining 620 persons scored the 2 samples identically. While a larger proportion of the tasters expressed no preference in 1953, using the hedonic scales, than in 1952 when they were specifically requested to make a choice, the percentage of those stating a preference who favored the 18% wine (56.6% in 1952; 55.3% in 1953) was gratifyingly consistent (Table 3).

When the triangular test was employed on these 2 wines to test further the reproducibility of different methods, out of 713 participating, only 277 (38.5%) were able to separate the wines correctly; this response, however, is highly significant for this large number of tests. The questionnaire also asked for an expression of preference, either for the duplicates or the odd sample, as chosen. Of those who were able to separate correctly, 56.0% preferred the 18% wine.

It is interesting to note, in this connection, that these 2 wines were tested in our laboratory at Davis, using the triangular test with small trained panels of experienced tasters. Here the proportion of judges correctly differentiating between the samples was not statistically significant. Out of 76 separate triangles there were only 19 (25%) correct separations. Results from the State Fair surveys also showed that infrequent wine users were proportionately better able to discriminate between the different alcohol contents in this triangular test than were the more frequent users. It is possible that frequent use of alcohol makes the expert panel somewhat less sensitive to its effects than most individuals. It is also true, of course, that a higher proportion of correct responses is required for a given significance level where the total number of tests is small than when it is much larger.

## DISCUSSION

The triangular test proved, however, to be poorly suited to this type of survey. It required a larger number of personnel to administer, and constant watchfulness to avoid arrors in coding and serving the samples while maintaining a random arrangement of the 6 possible sample arrangements. More time was needed for each taster to complete the test, and most of the participants, who, of course, had had no previous knowledge of the triangular design, were initially somewhat confused, and usually required an individual explanation.

Use of a hedonic scale with large numbers of people permits comparisons to be made not only between wines served together at a single session, but also among all of the various wines presented at the surveys. This is not possible when a simple indication of preference is all that is required, since such a choice does not indicate whether both samples are liked very much or very little, or how much one sample is preferred to the other. The hedonic scale proved particularly useful in assessing the consumer response to an experimental, low-alcohol, sweet, sparkling muscat wine. It was of such an unusual type that it was impossible to select a known wine type that could reasonably be compared with it directly. It was, therefore, served alone wih he same hedonic-scoring questionnaire as was used with the other 1953 wine samples. Its high average score of 7.9 put it in a separate class from the other wines served (which averaged around 7.0), and indicated an exceptionally favorable acceptance by consumers (Table 2). This was borne out also by the comments made. Not only did most of these express enthusiastic approval, but also it was noted that the number of comments of all sorts was proportionately far greater for this wine than for any other.

The use of I. B. M. cards to tabulate and analyze data was found to be extremely useful and time-saving. It permitted us to obtain averages, count preference, and calculate correlations with a relatively small amount of effort. Once the information from each questionnaire

**TABLE 3**

**Comparison of preference data for ports of different alcohol content**

| | Number preferring | | | Number no preference | Total |
|---|---|---|---|---|---|
| | 18% Port | 20% Port | | | |
| 1952 Fair (Paired Comparison—Preferential) | 581 (49.4%) | 446 (37.9%) | 1027 | 149 (12.7%) | 1176 |
| 1953 Fairs (Paired Comparison—Hedonic Scoring) | 1352 (44.2%) | 1093 (35.7%) | 2445 | 620 (20.1%) | 3065 |
| 18% served first | 743 | 509 | 1252 | 332 | 1584 |
| 20% served first | 609 | 584 | 1193 | 228 | 1421 |
| 1953 Fair (Triangular test) | 155 (56.0%) | 110 (39.7%) | 265 | 12 (4.3%) | 277[1] |

[1] Total *correct* separations; in all, 713 people took the triangular test.

had been punched on a card it was possible by making appropriate adjustments in the collating machine and sorter to correlate any combination of two or more factors rapidly and accurately. For example, we could determine how many men in each age group, who drink wine a few times a month, prefer sweetened red table wine to dry red table wine; or to tabulate, for the experiment in which 2 identical samples were served, how often they were scored 1, 2, 3 or more points apart. We found it convenient to code and punch the more frequently occurring comments as well as the hedonic scores, and obtained many useful correlations in this way. For example, the remark, "too sweet," or its equivalent, applied to the sparkling muscat wine was found to originate with greater frequency among frequent users of wine, among males, and among the younger age groups, thus substantiating some of the observations made in 1951 with respect to sweetness.

## SUMMARY

Consumer reaction to several types of wine was studied three successive years, 1951, 1952, and 1953, using California fairs as locales for the experiments.

The questionnaires used were amended each year in order to arrive at an economical and efficient type of questionnaire, and yet derive the necessary amount of information. The best type of questionnaire found, in these studies, was one requiring information as to age group, sex, frequency of use of wine and employing two hedonic scales, one for each of two wines being compared simultaneously. The hedonic scales measured the degree of *like* and *dislike* in nine steps. A space allowed for comments proved to be very helpful.

A triangular test, to determine the difference in alcohol between two Port wines, if detectable, was given one full day in 1953. A significant difference and preference was found, but the important discovery was that there existed a bias for choosing as odd the middle sample of the three presented.

As a means for testing consumer reaction, the triangular test was found poorly suited, due to the supervision required in conducting the test, and due to the confusion of the tasters caused by the presentation of three samples.

In the paired comparison tests, using hedonic scales, a bias for the first sample served was evident. This was particularly exemplified by serving two samples of the same wine in one of the series, with the result that the preference was strongly in favor of the first served.

The hedonic scale was given values ranging from 1 to 9, the latter number being assigned to the highest degree of *like*. In this manner, a statistical analysis could be made on the translated results. Arbitrarily, equal weight was allowed for each hedonic step, since no experimental information was available upon which to base a more accurately weighted scale.

The efficient analysis of the information obtained for 1952 and 1953 was made possible by the use of I. B. M. cards and machines. The necessary data was punched, one card for each questionnaire. Considering that 7482 persons participated in the 1952 survey, and that there were 16330 responses from the 1953 survey, the cards proved to be the only economical manner for tabulating the results.

### Acknowledgment

Funds for this work were made available by contract with the Wine Advisory Board.

## LITERATURE CITED

1. Helm, E., and Trolle, B. Selection of a taste panel. *Wallerstein Lab. Comm.*, **9**, 181-4 (1946).
2. Harrison, S., and Elder, L. W. Some applications of statistics to laboratory taste testing. *Food Technol.*, **4**, 434-439 (1950).
3. Peryam, D. R., and Girardot, N. F. Advanced taste test method. *Food Eng.*, **24**, 58 (1952).

# Measuring the Size Compliance of Foods[a]

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(Manuscript received July 13, 1954)

**Measuring the size compliance of foods is a control problem of long standing. The problem stems not only from the complex nature of foods, but also from a lack of data on size compliance tests. In some cases, no size requirements whatever are specified, and therefore, no method is used. In others, it appears that the only existing procedures are unpublished trade methods. This paper presents methods considered adequate for performing size tests for the more common foods with size compliance requirements, and for those foods without such requirements which fall into this category. Methods presently available and considered satisfactory are given and correlated with a list of familiar foods tested for size. Proposed methods are given where no methods exist or to replace ones that do exist. Size determination is defined, and standards are specified for sieves, screens, calipers, rulers and measuring containers. Simplified methods for indirect measurement by count per container volume are specified for many foods.**

The human head, hand, foot, arm, thumb, and the circumference of the waist were doubtless man's first standards of measure. Computation probably began when he started to count with his fingers and to use sticks and stones to designate quantities. Not until the advent of numerals and more precisely defined standards, did a universal language in dimensions and volume become available. The constant need for ever more exact methods of measurement has stimulated man to develop the standard meter, calipers, ocular micrometers *(61)*, and the electron microscope *(60)*, to name but a few of the tools of precision.

The need for measuring foods arose comparatively recently in human history. The invention of sieves, which stemmed from the need for a practical method of measuring countless particles of small size, has been of immense helpfulness in fulfilling this need. It is simple enough to measure apples and asparagus, but with salt, spices, sugar, and the like, it becomes too great a task to determine the particle size by dimensional measurement or count. For example, if a single 1-inch cube of such an item is cut into smaller cubes 0.001 inch on an edge, 1 billion particles result. If a size compliance test were to be made, it would not be practical to do it with calipers or micrometers. But the task becomes easy when sieves are available. An 8-inch diameter testing sieve with 200 meshes per inch has approximately 2 million openings, each theoretically capable of performing a measurement for every stroke of a shaking operation.

The first sieve is said to have been produced by John Sellers *(30)*, of Philadelphia, in 1768. The first wire sieves to be manufactured commercially were produced by Edwin Gilbert of Gilbert Bennett & Company *(30)*, of Georgetown, Conn., in 1834. In 1907, a series called the I. M. M. Sieve Series *(54)* was adopted by the Institution of Mining and Metallurgy of London. As originally conceived, the wire and the opening were to be of the same diameter in order to eliminate shifting of the wires. The series has become almost obsolete, being largely replaced by the British Standard Sieve Series, which was adopted by the British Standards Institution in 1932. The most recent of this series is B.S. 410:1943. The openings closely parallel the Tyler Screen Scale, the slight variation being due to the difference between U. S. and British Standard wire *(54)*. Another sieve series, the German Standard Sieve Series *(54)* DIN No. 1171 is a metric series in use in some European countries. The sieves are designated both by number and the number of meshes per square centimeter. Sieve tests made with any one of these sieves may be compared with any other series, including the U. S. Standard Sieve Series, by the use of Tables 2 and 3, and cumulative direct or logarithmic plotting paper *(54)*.

In 1919, the Bureau of Standards proposed a series of sieves based on a 1-mm. opening. However, these were never made available since odd diameters of wires *(53)* were specified which would have made fractional non-standard meshes necessary. This condition was corrected in 1938 by specifying a range of permissible wire diameters for each sieve opening. The wire diameters specified included those used in the Tyler Standard Screen Scale Sieve Series *(53)*. The U. S. Sieve Series and the Tyler Sieve Series may be used interchangeably. The principal difference between the two is that the Tyler Series is numbered according to the number of meshes per linear inch, while the U. S. Series is numbered arbitrarily or identified by a micron designation based on the ratio of the fourth root of 2 to 1. The U. S. Sieve Series system of numbering does not always corespond to the mesh count, hence specifications which read "U. S. Standard Mesh Number" are incorrect.

## SCOPE AND DEFINITIONS

Table 1 indicates the many methods available for evaulating particle size. It shows the need for a wide variety of elaborate equipment and technical skills. This paper, on the other hand, is concerned with methods which are generally used in food laboratories and which may be performed easily with readily available and inexpensive equipment. For this reason the procedures specified herein are limited to linear, volumetric, and granulometric evaluations of food sizes, with particular emphasis on the latter method. Essentially, food products of non-animal origin are dealt with. Standard procedures for estimating the particle size of meat or meat products are not available since very few such products are in any way dependent upon the particle size of the ingredients *(11)*. Such items as hams or sausages might very well be measured by methods 2 or 3 given under the section entitled "List of Methods for Measuring Size Compliance."

[a] Presented at the Fourteenth Annual Meeting of IFT, June 28, 1954.

**TABLE 1**
**Methods of evaluating size**

| Method | Remarks | Example | Reference |
|---|---|---|---|
| I. Macro particles | | | |
| A. Linear | | | |
| 1. Length, depth, diameter | Ruler, caliper, micrometer | Canned asparagus, dried apricots | 13 |
| B. Counting | | | |
| 1. No./Vol. | Number per standard container | Beets | 59 |
| 2. Wt./Vol. | Weight per unit item | Fruitcake | 38 |
| 3. No./Wt. | Count per pound | Cookies | 37 |
| C. Mechanical | | | |
| 1. Dry sieve | Amount retained or passed through sieve | Sugar, salt, cereals | 5 |
| 2. Wet sieve | Sieve acts as strainer or filter | Tomato products | 32 |
| II. Micro particles | | | |
| A. Permeation | | | |
| 1. Liquid | Rate of liquid passing through packed sample has direct relationship to particle size | Cocoa | 7 |
| 2. Gas | Similar to liquid method | Insecticides | 22 |
| B. Sedimentation | | | |
| 1. Increment | | | |
| a. Pipet | Aliquots pipetted at timed intervals, dried, and solids weighed | Clays | 2 |
| b. Hydrometric | Specially designed hydrometer used to obtain specific gravity at timed intervals or at different levels | Welding electrode coating powders | 4 |
| c. Photoelectric | Particle size correlated with light transmission at fixed levels at timed intervals | Flour | 10 |
| d. Manometric | Side-arm manometer is fixed at definite position, and pressure recorded at timed intervals | Insecticidal dusts | 23 |
| e. Photographic | Direct measurement of distance traveled by particle in timed interval | Cement, pigments | 6 |
| 2. Cumulative | | | |
| a. Balance | Cup or pan collects particles settled at certain levels in specified time | Hydrated lime | 3 |
| b. Manometric | Differential manometer used to measure pressure | Pigments | 31 |
| C. Optical | | | |
| 1. Microscopic | | | |
| a. Direct | Optical micrometer | Potato starch | 66 |
| b. Projection | Image projected on screen, and measured | Pigments | 12 |
| c. Photomicrographic | Linear measurement of magnified, photographed particle | Pigments | 24 |
| d. Counting chamber | Weighed sample counted in haemacytometer | Ceramics | 1 |
| 2. Ultramicroscopic | Indirect lighting gives Tyndall-like effect | Powders, colloids | 48 |
| 3. Electron microscopic | For submicroscopic particles | Carbon blacks used in rubber compounding | 60 |
| 4. Refractometric | Size related to birefrigence | Egg albumin | 20 |
| 5. Turbidimetric | Ratio of intensity of transmitted light to incident light | Sulfur | 44 |
| 6. Nephelometric | Ratio of intensity of scattered light to incident light | Starch | 33 |
| 7. Angular dependence light scattering | Variation of intensity of scattered light with angle of scattering | Sulfur sols. | 47 |
| D. Electrical | | | |
| 1. X-ray | Diffraction and absorption | Nickel catalysts, colloidal gold | 9 |
| 2. Infrared scattering | Employs an effect which is similar to nephelometric method | Rubber pigments | 21 |
| E. Miscellaneous | | | |
| 1. Centrifugal | | | |
| a. Ordinary | Up to 13,000 times the force of gravity | Clays | 40 |
| b. Super- | 13,000 to 100,000 times the force of gravity | Pigments | 28 |
| c. Ultra- | 100,000 to 7,000,000 times the force of gravity, or greater | Starch | 48 |
| 2. Film balance | Powder spread in mono-particle layer on surface of liquid, and film balance used to determine surface pressure-area relationship | Starch | 25 |
| 3. Elutriation | | | |
| a. Gas | Particles of varying sizes separated by upward flow of gas; velocity of flow determines size | Clays | 45 |
| b. Liquid | Similar to gas method | Quartz, clays | 58 |
| 4. Adsorption | | | |
| a. Dye | Intensity of dye adsorbed is proportional to total surface | Lead sulfate | 43, 41 |
| b. Radioactivity | Intensity of decay count proportional to total surface | Lead sulfate | 42, 41 |
| 5. Leucometric | Measurement of whiteness of a mixture of sample and standard black coal dust | Flour | 63 |
| 6. Rate of solution | Size related to rate of solution in solvent or corrosive medium | Powders | 7 |
| 7. Ultrasonics | Transmission of sound is diminished as wavelength approaches grain size | Powders | 26 |

A question arises as to whether dimensional evaluations of a single magnitude should be called "determinations" or "measurements." Although authors have used the terms interchangeably, Roberts *(50)* feels that such evaluations are properly called measurements, whereas evaluations involving more than one magnitude should be called determinations. Thus an evaluation of the fineness of flour by the sedimentation rate would be called a determination since the data obtained give size as a function of mass, shape, surface texture, and the like. Hackh's Chemical Dictionary *(27)* restricts the term "measure" to appliances used to determine length, diameter, volume, and capacity. In this paper, *measurement* is used to describe the evaluation of one or more of the three dimensions of a food by operations of a single magnitude.

British Standards *(34)* defines the end point of a sieving test as the point at which the elimination of "near mesh" particles has attained the "practical limit." The material remaining on the sieve after the end point has been reached is termed "oversize," while that passing through the sieve is referred to as "undersize." These terms are used in a like sense in this paper.

The practical limit as an end point is achieved in one of two ways; namely, sieving for a specified length of time, or sieving until a specified weight or percentage weight, per unit time passes through the sieve. In the latter case, sieving is considered complete when less than 0.2% by weight of the sample passes through the sieve in a 2-minute period. British Standards has found evidence for preferring the latter method. Sieving for a specified length of time has been found unsatisfactory as a general definition for end point due to differences occurring in the same food, to differences in sieving techniques, and to the friability of certain foods such as cornflakes or oatmeal. In consequence, this laboratory has adopted the end point preferred by British Standards with but slight modification. The end point as used herein, may be defined as follows: "Sieve until the rate at which particles pass the sieve is reduced to not more than 0.1% by weight per minute."

**TABLE 2**

**Comparison of U. S., British and German sieve series with Tyler equivalents**

| Tyler | U. S. [1] | | British Standard [2] | | I. M. M.[3] | | German Din [4] | | | Tyler |
|---|---|---|---|---|---|---|---|---|---|---|
| Equiv. Mesh | Sieve No. | Opg. Mm. | Mesh No. | Opg. Mm. | Sieve No. | Opg. Mm. | Din. No. | Mesh per sq. cm. | Opg. Mm. | Equiv. Mesh |
| 3½ | 3½ | 5.66 | ... | ... | ... | ... | 1 | 1 | 6.000 | 3½ |
| 4 | 4 | 4.76 | ... | ... | ... | ... | ... | ... | ... | 4 |
| 5 | 5 | 4.00 | ... | ... | ... | ... | ... | ... | ... | 5 |
| 6 | 6 | 3.36 | 5 | 3.353 | ... | ... | 2 | 4 | 3.000 | 6 |
| 7 | 7 | 2.83 | 6 | 2.812 | ... | ... | ... | ... | ... | 7 |
| ... | ... | ... | ... | ... | 5 | 2.540 | ... | ... | ... | ... |
| 8 | 8 | 2.38 | 7 | 2.411 | ... | ... | 2½ | 6.25 | 2.400 | 8 |
| 9 | 10 | 2.00 | 8 | 2.057 | ... | ... | 3 | 9 | 2.000 | 9 |
| 10 | 12 | 1.68 | 10 | 1.676 | ... | ... | 4 | 16 | 1.500 | 10 |
| ... | ... | ... | ... | ... | 8 | 1.600 | ... | ... | ... | ... |
| 12 | 14 | 1.41 | 12 | 1.405 | ... | ... | ... | ... | ... | 12 |
| ... | ... | ... | ... | ... | 10 | 1.270 | ... | ... | ... | ... |
| 14 | 16 | 1.19 | 14 | 1.204 | ... | ... | 5 | 25 | 1.200 | 14 |
| ... | ... | ... | ... | ... | 12 | 1.059 | ... | ... | ... | ... |
| 16 | 18 | 1.00 | 16 | 1.003 | ... | ... | 6 | 36 | 1.020 | 16 |
| 20 | 20 | .84 | 18 | .853 | ... | ... | ... | ... | ... | 20 |
| ... | ... | ... | ... | ... | 16 | .795 | 8 | 64 | .750 | ... |
| 24 | 25 | .71 | 22 | .699 | ... | ... | ... | ... | ... | 24 |
| ... | ... | ... | ... | ... | 20 | .635 | ... | ... | ... | ... |
| 28 | 30 | .59 | 25 | .599 | ... | ... | 10 | 100 | .600 | 28 |
| ... | ... | ... | ... | ... | ... | ... | 11 | 121 | .540 | ... |
| 32 | 35 | .50 | 30 | .500 | ... | ... | 12 | 144 | .490 | 32 |
| 35 | 40 | .42 | 36 | .422 | 30 | .424 | 14 | 196 | .430 | 35 |
| 42 | 45 | .35 | 44 | .353 | ... | ... | 16 | 256 | .385 | 42 |
| ... | ... | ... | ... | ... | 40 | .317 | ... | ... | ... | ... |
| 48 | 50 | .297 | 52 | .295 | ... | ... | 20 | 400 | .300 | 48 |
| 60 | 60 | .250 | 60 | .251 | 50 | .254 | 24 | 576 | .250 | 60 |
| 65 | 70 | .210 | 72 | .211 | 60 | .211 | 30 | 900 | .200 | 65 |
| 80 | 80 | .177 | 85 | .178 | 70 | .180 | ... | ... | ... | 80 |
| 100 | 100 | .149 | 100 | .152 | 80 | .160 | 40 | 1600 | .150 | 100 |
| ... | ... | ... | ... | ... | 90 | .139 | ... | ... | ... | ... |
| 115 | 120 | .125 | 120 | .124 | 100 | .127 | 50 | 2500 | .120 | 115 |
| 150 | 140 | .105 | 150 | .104 | 120 | .104 | 60 | 3600 | .102 | 150 |
| 170 | 170 | .088 | 170 | .089 | ... | ... | 70 | 4900 | .088 | 170 |
| ... | ... | ... | ... | ... | 150 | .084 | ... | ... | ... | ... |
| 200 | 200 | .074 | 200 | .076 | ... | ... | 80 | 6400 | .075 | 200 |
| 250 | 230 | .062 | 240 | .066 | 200 | .063 | 100 | 10000 | .060 | 250 |
| 270 | 270 | .053 | 300 | .053 | ... | ... | ... | ... | ... | 270 |
| 325 | 325 | .044 | ... | ... | ... | ... | ... | ... | ... | 325 |
| 400 | 400 | .037 | ... | ... | ... | ... | ... | ... | ... | 400 |

[1] National Bureau of Standards LC-584 and A. S. T. M. E-11.
[2] British Standards Institution, London BS-410:1943.
[3] Institution of Mining and Metallurgy, London.
[4] German Standard Specification DIN. 1171.

A survey of the methods in practical use by analysts shows that a combination of time and rate is satisfactory for most samples. It is for this reason that the list of methods is set up with time limits. These time limits generally give complete sieving. Incomplete tests are, of course, continued longer. After having gained some experience in doing sieve tests, a technician can judge the approximate end point with a fair degree of accuracy. This is sufficient for ordinary analyses. However, where there is a question of conformity to contract specifications, a rigid definition is necessary for end point. It is believed that the definition given here satisfies such a requirement.

## APPARATUS

The sieves and screens used herein for determining the size compliance of foods conform to the specification of the National Bureau of Standards. This specification contains requirements for a fine series of woven wire cloth sieves, a coarse series, and perforated metal screens. It also covers dimensions of frame, type of material, type of weave, sieve openings, permissible variations, and identification. Both the U. S. Sieve Series and the Tyler Standard Screen Scale Sieve Series meet the specifications adopted by the National Bureau of Standards, LC-584, American Society for Testing Materials E11-39, American Standards Association ASA-Z23.1-1939, American Association of State Highway Officials T-27, and Federal Specification RR-S-366a *(53)*. The 8-inch diameter, 2-inch height sieves *(52)* are considered standard for most sieve analyses, while other sizes are specified when required. The Tyler Company *(55, 65)*, has 7,000 sieve specifications, and makes a standard screen scale testing sieve as fine as 400 meshes per linear inch. British Standard Methods *(34)* gives specifications for various types of sample dividers and also gives details for an auxiliary vibrator for attaching to 8-inch sieves which simulates the effectiveness of hand vibration. British Standard Methods and the W. S. Tyler Company *(56)* give methods for taking samples and reducing sample size without the use of expensive equipment.

Tests with shaking machines have not been specified due to the diversity of machines available. However, shaking machines which give results equivalent to those obtained by the methods specified may be used. Many are suitable for performing sieve tests on samples other than those requiring brushing and their use often effects a considerable saving in effort. Nevertheless, they are generally not as effective as hand shaking *(34)*. This has been noted in this laboratory, also. For example, some samples tested by machine shaking, using the "Cenco-Meinzer Sieve Shaker," were found to require considerably more time than the 2 minutes of hand shaking specified in Method 10 of this paper to give similar results. This particular type of shaking machine lacks the sharp side tapping action that appears necessary for cleaning the sieve openings. Other items useful in connection with performing sieve tests on foods are torsion balances, timers, and tabulating and plotting paper *(57)*.

Measurement of size by the volume which a certain number of pieces of food occupy is particularly applicable to canned fruits, and to some other foods (Table 4). To facilitate size by volume measurement, common cans are specified as standard sized containers *(49)*. These are referred to by the canners' designation which is derived from the nominal dimensions. The first digit represents inches while the next two digits represent a fraction expressed as sixteenths of an inch. The diameter is always given first and is followed by the height. For example, the No. 2½ can has the canners' designation 401 x 411, which means that the diameter is equal to 4 1/16 inches while the height is equal to 4 11/16 inches.

**TABLE 3**

**Tyler standard screen scale sieves [1]**

| Tyler standard screen scale $2^{1/2}$ opening in inches | For closer sizing ratio $2^{1/4}$ opening in inches | Mesh | Diameter of wire, decimal of an inch | U. S. series equivalents (fine series) | |
|---|---|---|---|---|---|
| | | | | Micron designation | Number |
| 3 | .... | .... | .207 | .... | .... |
| 2 | .... | .... | .192 | .... | .... |
| 1.5 | .... | .... | .162 | .... | .... |
| 1.050 | 1.050 | .... | .148 | .... | .... |
| .... | .883 | .... | .135 | .... | .... |
| .742 | .742 | .... | .135 | .... | .... |
| .... | .624 | .... | .120 | .... | .... |
| .525 | .525 | .... | .105 | .... | .... |
| .... | .441 | .... | .105 | .... | .... |
| .371 | .371 | .... | .092 | .... | .... |
| .... | .312 | 2½ | .088 | .... | .... |
| .263 | .263 | 3 | .070 | .... | .... |
| .... | .221 | 3½ | .065 | 5660 | 3½ |
| .185 | .185 | 4 | .065 | 4760 | 4 |
| .... | .156 | 5 | .044 | 4000 | 5 |
| .131 | .131 | 6 | .036 | 3360 | 6 |
| .... | .110 | 7 | .0328 | 2830 | 7 |
| .093 | .093 | 8 | .032 | 2380 | 8 |
| .... | .078 | 9 | .033 | 2000 | 10 |
| .065 | .065 | 10 | .035 | 1680 | 12 |
| .... | .055 | 12 | .028 | 1410 | 14 |
| .046 | .046 | 14 | .025 | 1190 | 16 |
| .... | .0390 | 16 | .0235 | 1000 | 18 |
| .0328 | .0328 | 20 | .0172 | 840 | 20 |
| .... | .0276 | 24 | .0141 | 710 | 25 |
| .0232 | .0232 | 28 | .0125 | 590 | 30 |
| .... | .0195 | 32 | .0118 | 500 | 35 |
| .0164 | .0164 | 35 | .0122 | 420 | 40 |
| .... | .0138 | 42 | .0100 | 350 | 45 |
| .0116 | .0116 | 48 | .0092 | 297 | 50 |
| .... | .0097 | 60 | .0070 | 250 | 60 |
| .0082 | .0082 | 65 | .0072 | 210 | 70 |
| .... | .0069 | 80 | .0056 | 177 | 80 |
| .0058 | .0058 | 100 | .0042 | 149 | 100 |
| .... | .0049 | 115 | .0038 | 125 | 120 |
| .0041 | .0041 | 150 | .0026 | 105 | 140 |
| .... | .0035 | 170 | .0024 | 88 | 170 |
| .0029 | .0029 | 200 | .0021 | 74 | 200 |
| .... | .0024 | 250 | .0016 | 62 | 230 |
| .0021 | .0021 | 270 | .0016 | 53 | 270 |
| .... | .0017 | 325 | .0014 | 44 | 325 |
| .0015 | .0015 | 400 | .001 | 37 | 400 |

[1] The Tyler Standard Screen Scale Sieves Series has been expanded to include intermediate sieves for closer sizing which gives a ratio of the fourth root of two or 1.189 between openings in successive sieves.

A piece of equipment commonly used in the produce industry to measure the diameter of fruits and vegetables is the perforated plate. One type of such plate is made by the Salt Lake Stamp Company *(46)* and consists of 7 aluminum plates fastened together with a pin so that they swing freely. The first plate has holes of the following diameter in inches: 1, 1¼, and 2¼; the second, 1½, 1⅜, and 1¾; the third, 1⅞, and 2; the fourth ⅞, and 2½; the sixth, ½, ¾, and 2¾; and the seventh, ¼, ⅜, and 3. The fifth plate has half circles with openings 1¼, 2, and 2¼ inches in diameter. The appartus is light in weight and may be carried easily in the pocket.

Apparatus useful in measuring the compliance of larger foods are micrometers, calipers, and rulers. Rulers which are unaffected by moisture are desirable since they are often used to measure the sizes of such foods as canned fruits or vegetables. This laboratory has found plastic rulers suitable for the purpose. The type of caliper used in this laboratory is a micrometer which measures to 0.01 mm. It is useful for such measurements as the thickness of noodles. Since extreme accuracy is usually not required, almost any of the standardized instruments available today are satisfactory for the purpose of measuring the size compliance of foods. For very fine particles, or where great accuracy is desired, other apparatus and methods are available (Table 1) but these are not within the scope of this paper.

## METHODS

In setting up standard methods for size measurements with sieves, a number of factors must be taken into consideration. Important factors are standard sieves, sieve sizes, sample size, angle of holding, tapping, shaking time, brushing, weighing, and definition of end point. Weber and Moran *(61)* state that the shaking time is very important especially when the particles are small. They maintain that enough time should be allowed so that a constant is approached, but that additional time allows closely sized particles the opportunity of falling through openings which are slightly larger than the average. Variations in sieve openings make a great deal of difference in the results obtained from a sieve analysis. This is especially true in the case of very small, closely ranged particles. Weber and Moran have developed "a precise method for sieving analyses" by determining microscopically the effective opening of plain-weave sieves and showing that this value is independent of the size distribution of the material tested. Appropriate corrections are applied to adjust data obtained with calibrated sieves.

Texts available to the food laboratory usually do not give methods for performing size measurements. However, some methods for sieve testing are provided in Browne and Zerban *(5)*, British Standard Methods *(34)*, U. S. Federal Specifications, and Government Standard Inspection Procedures. Browne and Zerban lists mechanical methods for determining the grain size of raw and refined sugars both by dry sifting and wet sifting. Methods are also given whereby grain-size may be determined by magnification, by projection of an image on a screen, and by weight per unit volume. In the latter method the weight of a known volume of sugar is divided by the weight of an equal volume of water. The figure thus obtained varies inversely with the average grain size of the sugar. A method is also given for calculating the *average grain size* of sugar from data obtained by a sieve analysis. Douwes Dekker *(5)* proposes a method for determining the *specific grain size* of sugar by a calculation based on specific surface.

British Standard Methods *(34)* gives procedures for performing sieve tests by both hand and machine methods, and gives wet and dry techniques. Procedures are not given for linear or volumetric measurements, or for defatting or brushing techniques. British Standard Methods takes great care to make clear every detail and each step of the procedures, from sampling through sieving, to reporting the results. The sieving method is essentially the same as that specified herein (Method 10) excepting that a piece of wood is used for tapping the higher side of the uppermost sieve frame instead of tapping by hand. The sieve is then grasped in both hands and is shaken an unspecified number of times while being rotated through an angle of approximately 60° in the plane of the gauze, which is about 30° from the horizontal. This operation of alternately tapping and shaking, is continued for an initial period of five minutes. A preliminary procedure is given for removing fine dust by either a wet or dry method in preparation for the actual test.

In Table 4 more than one testing method is shown for many foods, especially fruits and vegetables, because it is desirable to limit the number of pieces oversize or undersize as well as to obtain the average size. In other cases, a study of the specification for that particular food will give the reason for specifying several methods. For example, 3 methods are listed for cocoa beverage discs due to the fact that 3 distinct sets of data are desired; the size of the finished disc, the number of oversize pieces left after the solubility test is performed, and the size of the cocoa beverage powder.

The methods listed for indirectly measuring the size of fruits and vegetables have been proposed by the authors in order to standardize size measurements. At present there is little or no national uniformity in measuring the size compliance of most fruits and vegetables. Florida oranges are graded according to one standard, California oranges to another. Eastern apples are marketed on the basis of diameter. Western apples are sold according to count per unit container. Produce buyers habitually buy large shipments of perishables on the seller's word, often buying the produce without having seen it *(19)*. Sellers normally grade their products by mechanical means of which there are many kinds available, such as screens, rollers, cables, and slats *(29)*. The methods listed here are not intended to replace or interfere with good commercial practice, but are offered as a means of establishing a workable laboratory standard for measuring size compliance where this is required. It should be noted that when size is indirectly determined by count per

## TABLE 4

### Correlation of foods and methods for measuring sizes

| Food | Method |
|---|---|
| Apples, canned | 3 |
| Apples, dehydrated | 10 |
| Apples, evaporated | 4 |
| Apples, fresh | 8, 2 |
| Apricots, canned, or fresh | 7, 2 |
| Apricots, dehydrated | 5 |
| Apricots, frozen | 6, 3 |
| Artichokes, canned, or fresh | 2 |
| Asparagus, canned, fresh, or frozen | 2 |
| Bakery mixes, prepared | 14 |
| Baking soda | 14 |
| Bananas | 2 |
| Barley, pearl | 12 |
| Beans, dry, or dried, canned | 10 |
| Beans, green and waxed, canned, or frozen | 2 |
| Beans, lima, canned, fresh, or frozen | 6, 2 |
| Beets, canned | 6, 2 |
| Beets, dehydrated | 10 |
| Beets, fresh | 8, 2 |
| Berries, frozen | 6, 2 |
| Beverage bases, dry | 10 |
| Biscuit and bread mixtures, prepared | 14 |
| Biscuit, hard bread, or biscuit, canned | 3 |
| Blackberries and similar berries, canned | 6, 2 |
| Blackberries, fresh | 6, 2 |
| Blueberries, canned, or fresh | 6, 1 |
| Blueberries, dehydrated | 10 |
| Bouillon, granulated, or powdered | 10 |
| Bouillon, cubes | 3 |
| Bread and rolls | 3 |
| Bread, canned | 3 |
| Bread mix and yeast, prepared | 14 |
| Broccoli, fresh, or frozen | 3 |
| Brussels sprouts, fresh, or frozen | 3 |
| Buttermilk solids, cultured, dry | 14 |
| Cabbage, dehydrated | 10, 2 |
| Cabbage, fresh | 8, 2 |
| Cake | 3 |
| Cake mixtures, prepared | 14 |
| Candy | 3 |
| Cantaloupes, fresh | 8, 2 |
| Carrots, canned, diced, or sliced | 6, 3 |
| Carrots, canned, whole | 2 |
| Carrots, dehydrated, or fresh | 10 |
| Cauliflower, fresh | 8, 2 |
| Cauliflower, frozen | 6, 3 |
| Celery, dehydrated | 10 |
| Celery, fresh | 3 |
| Cereal, compressed, premixed | 3 |
| Cereal, premixed with sugar and milk | 13 |
| Cereal, breakfast, prepared | 13 |
| Cereals, wheat, uncooked | 10 |
| Cheese bar, compressed | 3 |
| Cheese, grated | 10 |
| Cherries, canned, fresh, or maraschino | 6, 2 |
| Chewing gum | 3 |
| Chili powder seasoning | 11 |
| Chocolate, or sweet chocolate | 17 |
| Citron, candied | 1 |
| Cloves, ground | 11 |
| Cloves, whole | 2 |
| Cocoa | 16 |
| Cocoa beverage powder | 16 |
| Cocoa beverage, discs | 2, 10, 18 |
| Cocoanut, prepared, sweetened | 1, 16 |
| Coffee, whole, ground, or instant | 10 |
| Confections | 3 |
| Cookies | 3 |
| Corn, cream style | 19 |
| Corn, frozen, ear, or green, fresh | 2 |
| Corn, frozen, kernel | 16 |
| Cornmeal, regular, or degermed | 16 |
| Cornstarch | 14 |
| Corn, sweet, canned, ear | 2 |
| Corn, sweet, canned, kernel | 16 |
| Crackers | 3 |
| Cranberries, dehydrated, sliced, reconstituted | 19 |
| Cranberries, dehydrated, whole, or powdered | 10 |
| Cranberries, fresh | 10 |
| Currants, dried | 10 |
| Cucumbers, slicing, fresh | 8, 2 |
| Dates | 3 |
| Dessert powders, gelatin | 10 |
| Dessert powders, starch | 14 |
| Doughnut, pancake and waffle mix, prep. | 14 |
| Egg, stabilized, dehydrated | 14 |
| Eggplant, fresh | 8, 2 |
| Endive, escarole, or chicory, fresh | 2 |
| Figs, canned | 6, 2 |
| Figs, dried or evaporated | 9, 2 |
| Flour, buckwheat, graham, or wheat | 14 |
| Fruitcake, bar, canned, or fresh | 3 |
| Fruit cocktail, canned | 6, 2 |
| Fry mix, prepared | 14 |
| Gelatin, dry, plain, or dessert mix | 10 |
| Grains | 10 |
| Grape beverage crystals, synthetic | 10 |
| Grapefruit, canned | 6, 3 |
| Grapefruit, fresh | 8, 2 |
| Grapes, fresh | 6, 2 |
| Greens, mustard, or turnip, fresh | 2 |
| Hominy, dehydrated, or grits | 10 |
| Hominy, lye, canned | 6, 2 |
| Horseradish, dehydrated, ground | 10 |
| Horseradish, fresh, whole | 3 |
| Horseradish, prepared | 19 |
| Ice cream mix | 14 |
| Kale, fresh | 2 |
| Lemon juice powder, synthetic | 10 |
| Lemon peel, candied | 1 |
| Lemons, fresh | 8, 2 |
| Lettuce, fresh | 8, 2 |
| Limes, fresh | 8, 2 |
| Loganberries, canned, or fresh | 6, 2 |
| Macaroni | 3 |
| Marmalade, orange | 1 |
| Marshmallows | 3 |
| Melons, Casaba, Honey Ball, Honey Dew, Persian | 8, 2 |
| Meringue powder | 14 |
| Milk, dry, malted | 14 |
| Milk, dry product, sweetened | 14 |
| Milk, dry, powdered, whole, or skimmed | 14 |
| Milk, dry, whole, or nonfat solids | 14 |
| Mineral yeast food | 14 |
| Monosodium glutamate | 10 |
| Mushrooms, canned | 6, 2 |
| Mustard, dry, powdered | 14 |
| Noodles | 3 |
| Nuts, mixed, shelled, salted | 6, 3 |
| Nuts, unshelled, assorted, or mixed | 6, 3 |
| Oats, rolled | 13 |
| Okra, fresh | 2 |
| Olives | 6, 2 |
| Onions, fresh | 8, 2 |
| Onions, common, green, bunched | 2 |
| Onions, dehydrated | 10 |
| Orange juice powder, synthetic | 10 |
| Orange peel, candied | 1 |
| Oranges, fresh | 8, 1 |
| Parsley, dehydrated flakes | 10 |
| Parsley, fresh | 3 |
| Parsnips, fresh | 8, 2 |
| Peaches, canned, diced, or sliced | 6, 2 |
| Peaches, canned, halves, or whole | 7, 2 |
| Peaches, evaporated, or dried | 5 |
| Peaches, fresh | 8, 2 |
| Peaches, frozen | 6, 3 |
| Peanuts, roasted, salted | 10 |
| Pears, canned | 7, 2 |
| Pears, evaporated, or dried | 4 |
| Pears, fresh | 8, 2 |
| Peas, dry, split | 10 |
| Peas, canned, fresh, or frozen | 1 |
| Peppers, sweet, fresh | 3 |
| Pickles | 7, 2 |
| Pineapple, candied | 1 |
| Pineapple, canned, crushed | 19 |
| Pineapple, canned, diced, or sliced | 6, 2 |
| Plums and prunes, canned, or fresh | 7, 2 |
| Potatoes, canned, Irish, or sweet | 7, 2 |
| Potatoes, dehydrated, Irish, or sweet | 10 |
| Potatoes fresh, Irish, or sweet | 8, 2 |
| Pound cake, canned | 3 |
| Powder, baking | 14 |
| Prunes, dried, or evaporated | 9, 2 |
| Pumpkin, fresh | 2 |
| Radishes, fresh | 7, 2 |
| Raisins | 10 |
| Raspberries, canned, fresh, or frozen | 6, 2 |
| Rice, brown, or milled | 10 |
| Rhubarb, fresh, or frozen | 2 |
| Rutabagas, fresh, topped | 8, 2 |
| Salt, celery, garlic, or onion | 10 |
| Salt, table | 10 |
| Sauerkraut, canned or bulk | 2 |
| Shallots, green, bunched | 2 |
| Soup and gravy base | 10 |
| Soup, pea, precooked, dehydrated | 15 |
| Soups, dehydrated | 15 |
| Soy flour | 14 |
| Spaghetti | 2 |
| Spices, ground (general) | 10 |
| Spices, whole | 2 |
| Spinach, fresh | 2 |
| Squash, fresh | 8, 2 |
| Starch | 14 |
| Strawberries, fresh, or frozen | 6, 2 |
| Sugar, beet, or cane | 11 |
| Sugar, confectioners | 14 |
| Tangerines, fresh | 8, 2 |
| Tapioca | 10 |
| Tea | 10 |
| Tea, instant | 10 |
| Tomatoes, canned | 7, 2 |
| Tomatoes, fresh | 8, 2 |
| Tomato products, macerated | 19 |
| Turnips, fresh, topped | 8, 2 |
| Vermicelli | 2 |
| Vinegar, dry, imitation | 10 |
| Watermelons, fresh | 2 |
| Wheat, bran | 10 |
| Yeast, compressed | 3 |
| Yeast, dry | 10 |

**TABLE 5**

**Comparison of sieve test results by indefinite and definite methods**

| Analyst | Powdered Sugar | | | | Ground Paprika | | Ground Black Pepper | |
|---|---|---|---|---|---|---|---|---|
| | Percent Retained on U. S. No. 100 Sieve | | Percent Passed Through U. S. No. 200 Sieve | | Percent Passed Through U. S. No. 30 Sieve | | | |
| | Indefinite Method [1] | Definite Method [2] | Indefinite Method [1] | Definite Method [2] | Indefinite Method [3] | Definite Method [4] | Indefinite Method [3] | Definite Method [4] |
| A | 0.6 | 0.8 | 87 | 91 | 99.4 | 99.9 | 97.0 | 98.9 |
| B | 0.7 | 0.5 | 95 | 93 | 100.0 | 99.9 | 98.7 | 99.1 |
| C | 0.6 | 0.5 | 82 | 90 | 99.9 | 99.9 | 98.5 | 99.0 |
| D | 0.6 | 0.8 | 83 | 91 | 99.8 | 99.9 | 98.9 | 98.8 |
| E | 0.5 | 0.7 | 93 | 93 | 99.9 | 99.9 | 98.5 | 98.7 |
| F | 0.7 | 1.1 | 88 | 90 | 99.7 | 99.9 | 98.5 | 98.9 |
| G | 1.0 | 0.5 | 82 | 96 | 99.9 | 99.9 | 98.7 | 98.8 |
| H | .... | .... | .... | .... | 99.9 | 99.9 | 98.7 | 99.1 |
| I | .... | .... | .... | .... | 99.5 | 99.6 | 98.6 | 98.7 |
| J | .... | .... | .... | .... | 99.9 | 99.9 | 98.7 | 98.6 |
| K | .... | .... | .... | .... | .... | .... | 98.7 | 98.8 |
| L | .... | .... | .... | .... | .... | .... | 99.0 | 99.0 |

[1] Reference No. 15. [2] Method No. 14. [3] No Method Specified. [4] Method No. 11.

volume, the value obtained is only the average, and gives no indication of the number of pieces oversize or undersize. Hence, it is desirable to use maximum and minimum diameters and lengths in connection with count per volume.

Some of the results of the study made for the correlation of methods of sieving with the type of food to be sieved are given in Table 5, and in Figures 1 through 8 for 200-g. samples. The first 4 curves show the rate at which the sample passes through the specified sieve, while the last four show the change in rate with time. The effect of continued shaking on end point and friability is evident in the curves, and especially so in those where rate is plotted against time. In general, the curves have a fairly constant slope during the initial shaking period, then change rapidly during the end point phase, and again level off as the slope approaches a constant. The constant apparently never quite reaches zero as long as some sample remains on the sieve. This varies with different samples and depends on the friability of the sample, closeness of sample particle size to sieve opening size, closeness in range of particle size, and variations in the openings of the sieve. An attempt was made to utilize the point of maximum change in slope as the end point but this was unsuccessful. More success was had in defining end point as a constant related to the rate at one period of sieving divided by the rate at another period of sieving, the periods of time being of one minute duration. The idea was to cancel out part of the experimental error through division, but the slightly greater reproducibility obtained in trial tests did not warrant the extra effort involved in sieving and calculating. Hence, the end point as defined herein was left unchanged. The curves shown are typical of the results obtained from the many sieve tests performed by this laboratory during the past 5 years, and indicate the type of results which may be expected when performing a sieve test on a sample.

The sieving times given in the various methods have been observed to be generally adequate for the first period of testing. The weight of undersize or oversize should be taken at this time. The test should then be continued for one minute more to observe whether the end point has been reached as given under DEFINITIONS. If the end point has not been reached, the test should be continued until it is. The results of sieve tests should add up to 100%. If the results fall short of 100.0% by 0.5% or more, the test should be discarded *(34)*. The analyst should also report sample weight, sieve sizes, undersize, oversize, loss, method used, sieving time, and any unusual phenomena noted.

Of the methods presently available, the authors have selected the following on the basis of ease of performance, availability of standard equipment, reproducibility of results, and the other considerations mentioned elsewhere. Table 4 correlates this list of methods with the foods to which they are particularly applicable.

## LIST OF METHODS FOR MEASURING SIZE COMPLIANCE

1. Measure maximum length on X axis.
2. Measure maximum length on X and Y axes.
3. Measure maximum length on X, Y, and Z axes.
4. After restoration to normal shape, measure by Method 3.
5. Determine the shortest measurement across the face of the halved material when it is restored to its normal shape *(13)*.
6. Count pieces per No. 2½ can, canners designation 401 x 411, level full *(49)*.
7. Count pieces per No. 10 can, canners designation 603 x 700, level full *(49)*.
8. Count pieces per bushel level full. Bushel equals 35.2 liters.
9. After restoration to normal shape measure by Method 6.
10. Place a 100-g. sample on the top sieve of an assembled set of specified sieves, including cover and catch pan. With the left

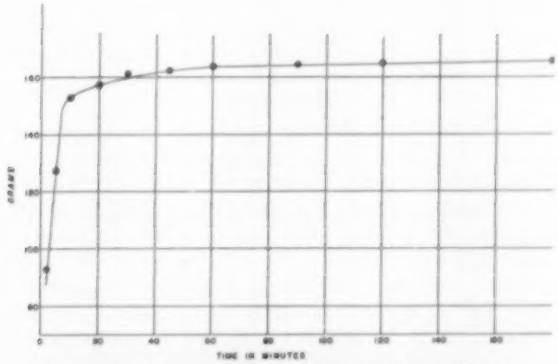

Figure 1. Rate of sieving—Cinnamon—Sieve No. 60.

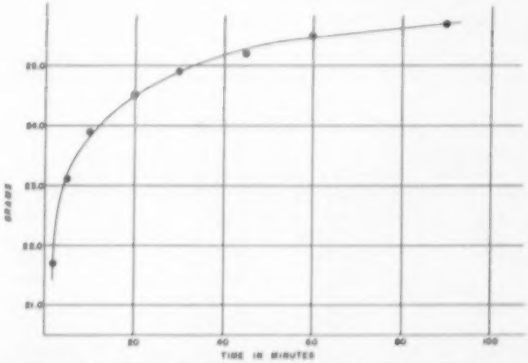

Figure 2. Rate of sieving—Table Salt—Sieve No. 70.

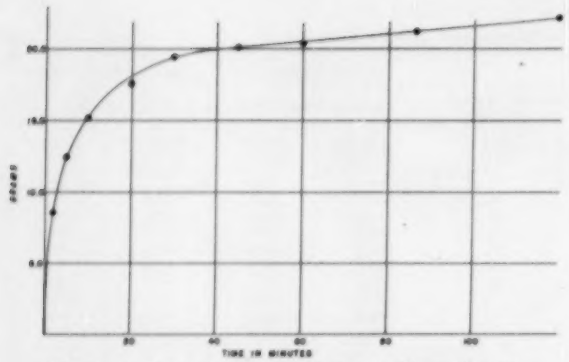

Figure 3. Rate of sieving—Cornmeal—Sieve No. 80.

hand hold the sieve assembly at an angle of about 30° from the horizontal so that the upper edge of the tilted plane is towards the right hand. Shake by striking the right side of the sieve assembly with a short, sharp stroke with the right hand moving in a horizontal plane. Strike at the rate of about 150 times per minute. After each 25 strokes turn the sieve assembly ⅙ of a revolution in the same direction. Continue shaking for 2 minutes *(16)*.

11. Follow Method 10, continue shaking for 5 minutes *(16)*.

12. Special sieves having lengthwise perforations are required for these tests. Place a representative 100-g. sample on the specified sieve with bottom pan attached. With both hands directly in front of the body and elbows close to the sides, hold the sieve assembly as level as possible so that when shaken the sieve perforations will be lengthwise to the direction of movement of the sieve assembly. With a steady motion move the sieve assembly from right to left approximately 10 inches, and return from left to right to complete the movement 20 times in approximately 13 seconds. The particles that lodge in the perforations shall be returned to the portion of the sample which remains on top of the sieve *(14)*.

13. Place a 100-g. sample in a sieve with bottom pan attached. Set the assembly on a smooth, level surface. Move it steadily 10 inches to the left, and return to its original position. Repeat this cycle 20 times in approximately 13 seconds *(15)*.

14. Place a 10-g. sample on the specified sieve with pan attached. Set on a flat, smooth, horizontal surface. Using a soft 3-inch hair brush, with handle pointing towards the operator at an angle of about 45°, stroke the sample along the perimeter of the sieve by drawing the brush towards the operator in 5 to 7 inch strokes. The full width of the brush should bear firmly upon the mesh, and follow the curvature of the perimeter. Rotate the sieve about ⅙ turn after each stroke in a direction opposite the motion of the brush. Brush at the rate of one stroke per second for five minutes, or until the end point has been reached.

15. Add 150 ml. of petroleum ether to approximately 100-g. of sample in a 250 ml. glass-stoppered graduated cylinder.

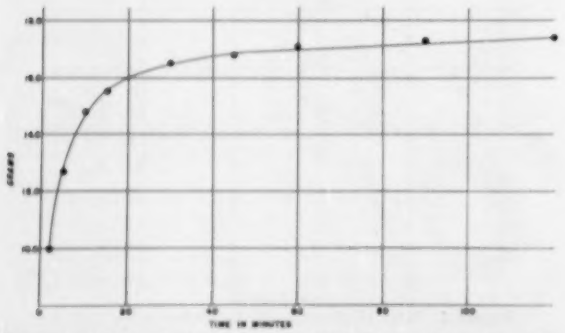

Figure 4. Rate of sieving—Granulated Sugar—Sieve No. 100.

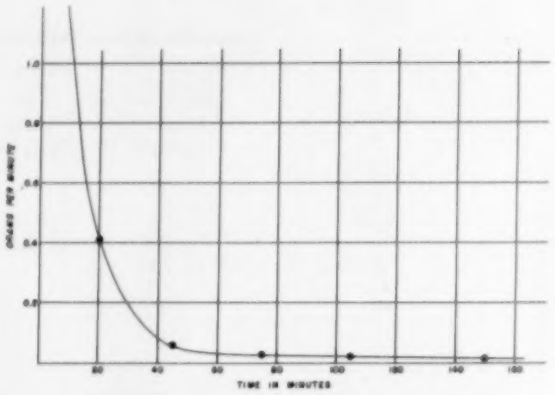

Figure 5. Change in rate of sieving—Cinnamon—Sieve No. 60.

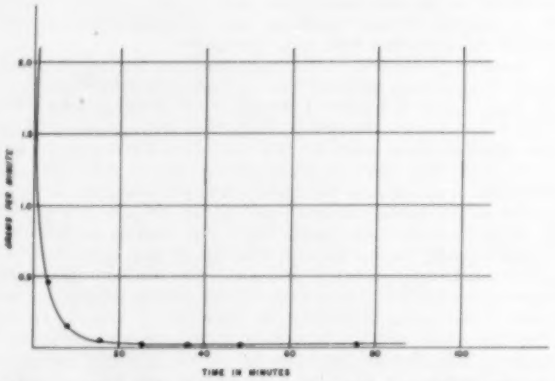

Figure 6. Change in rate of sieving—Table Salt—Sieve No. 70.

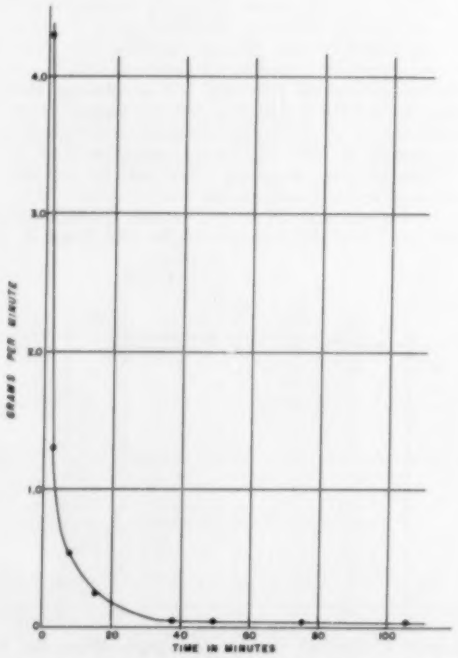

Figure 7. Change in rate of sieving—Cornmeal—Sieve No. 80.

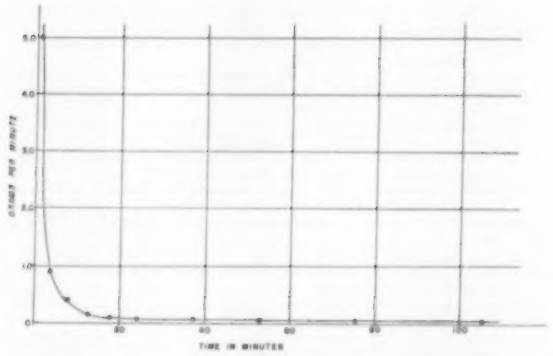

**Figure 8. Change in rate of sieving—Granulated Sugar—Sieve No. 100.**

Stopper and agitate gently for 2 minutes by repeated inversion and rotation of the cylinder to insure intimate contact of the solvent with the material. Pour contents on a sieve having openings smaller than any of the particles to be tested. Distribute the material evenly over the surface of the sieve, using care to avoid mechanical fracture of the particles. Allow to stand until the solvent has evaporated (approx. 30 minutes). Remove defatted material from the sieve and weigh. Shake as specified in Method 10 *(39)*.

16. Defat as in Method 15. Perform sieve test on the defatted sample as specified in Method 14.

17. Grate or shave sample to pass through U. S. Standard Sieve Number 8. Defat as in Method 15. Perform sieve test on 25 g. of defatted sample by Method 14.

18. Crush a wrapped sample unit in the hand and work gently until the lumps have disappeared. Remove wrapper, and add the crushed material to 10 ounces of water at 60° F. and stir vigorously with a spoon for 60 seconds. Pour the liquid through the specified sieve and count the pieces remaining on the sieve *(36)*.

19. Take sufficient sample with distilled water to give about 200 ml. volume having about 5% solids content. Pour the prepared sample on the top sieve of assembled set. Generally, sieve numbers 20, 40, 60, 100, and 140 are used in that order, the number 20 sieve on top. After most of the liquid has drained through, lift top sieve and wash as follows: Hold the sieve at an angle of about 45° as close to the next lower sieve as possible so that all of the water dripping from the top sieve is caught on the next sieve. Uusing a rubber tube fitted with a tapered glass nozzle, wash the particles on the sieve from below the cloth by introducing at an angle of 30° a stream of distilled water having a head of about 4 feet. Rotate the sieve slowly through 3 revolutions while washing material from center of sieve to lower side. Allow all liquid to drain from sieve, then wash particles into a 250 ml. graduated cylinder. Repeat washing and transfer procedures for each sieve in the order given. Make volume to 250 ml. with distilled water and mix thoroughly. Allow to stand a minimum of 15 hours, then read volume of sediment. Particles less than 0.1 mm. in diameter do not settle properly. Report volume of sediment for each sieve *(32)*.

## ACCURACY

The accuracy of particle size determinations made by conventional methods is discussed by Roberts *(51)* from which the following examples are cited. For the specific gravity settling time method for soils in suspension, an accuracy of 2% is given. Elutriators are accurate to about 3%. These employ air or water currents to separate powdered materials of 300 mesh or finer, and end up with a microscopic examination for particle size. Turbidimeters, measuring suspensions of finely powdered material, have an accuracy varying from 2 to 10%. It must be noted that in these methods, size classification is based not only on particle dimensions, but also on such factors as density, shape, and surface texture.

The reproducibility of several sieve test experiments is indicated in Table 5. For a material which passes through a sieve readily, such as paprika or pepper, an accuracy to 0.1% may be expected. A material which does not sieve readily may vary as much as 6% by the method specified in this paper. An example of a difficultly sieving material is powdered sugar. Data shown in Table 5, obtained from definite and indefinite methods, exhibit little difference for the spices. The reason for this stems from the nature of the samples. In this particular case, the spices readily passed through the required sieves and posed no difficulty in performing the test. Such particles as were retained on the sieve were quite large; thus there was little chance of their passing through. Closely-ranged samples, or samples which do not readily pass through sieves, might be expected to show less reproducibility in duplicate tests. This is indicated in the case of powdered sugar. Data under the column headed "Indefinite Method" were based on whatever weight and method the analysts doing the test thought was meant by the specification *(18)*, which reads, "Not more than 2% shall remain on a No. 100 U. S. Standard sieve and not less than 75% shall pass through a No. 200 U. S. Standard sieve when brushed through with a soft brush." Since the conditions of test gave freedom of choice as to the sample size, analysts A and D used 100 g., analysts B, C, and F used 10 g., and analysts E and G used 50 g. The amount specified in this paper is 10 g. Data obtained by Method 14 show better reproducibility than those obtained by following the indefinite specification procedure.

A further indication of the desired accuracy of sieve tests is given in British Standards *(34)* and herein under DEFINITIONS and METHODS. A wet sieving volume method for macerated tomato products, such as tomato juice, tomato paste, tomato puree, and catsup, reported by Kimball and Kertesz *(32)* gives results accurate to within 20% for duplicate tests.

## SUMMARY

Nineteen methods are given for measuring size compliance of most types of foods of non-animal origin. The methods of testing have been related to the types of foods for which they are particularly suited, and are listed in tabular form for ready reference. To facilitate size determintions, readily available standard apparatus has been specified.

### Acknowledgments

The authors are indebted to Lt. Col. Earl G. Kingdon, V. C., Quartermaster Subsistence Testing Laboratory, for his encouragement and assistance in the accomplishment of this study. Grateful appreciation is expressed to Murray H. Barsky of this laboratory, for preparing Table 1, and to Kimio Watanabe for performing the sieve tests. The authors thank the W. S. Tyler Company for permission to reproduce Tables 2 and 3.

## LITERATURE CITED

1. Amberg, C. R. Size determination with the hemacytometer. *J. Am. Ceram. Soc.*, **19**, 207-8 (1936).

2. Andreasen, A. H. M. The grinding of materials. Theoretical and experimental researches on particle-size distribution incident to the disintegration process. *Kolloid-Beihefte*, **27**, 349-458 (1928).
3. Bishop, D. L. A sedimentation method for determining the particle size of finely divided materials (such as hydrated lime). Nat. Bur. of Stds., *J. Research*, **12**, 173-83 (1934). Research Paper 642.
4. Blake, P. D. Comparison of methods for determining surface area and other particle-size data of fine powders, especially welding-electrode powders. *J. Soc. Chem. Ind.*, **68**, 138-48 (1949).
5. Browne, C. A., and Zerban, F. W. "Sugar Analysis." 1948, 3rd ed., John Wiley & Sons, Inc., New York.
6. Carey, W. F., and Stairmand, C. J. Size analysis by photographic sedimentation. *Trans., Inst. Chem. Eng.*, **16**, 57 (1938).
7. Carman, P. C. The determination of the specific surface of powders. *J. Soc. Chem. Ind.*, **57**, 225-34 (1938).
8. *Cereal Laboratory Methods.* 1947, 5th ed., American Association of Cereal Chemists, University Farm, St. Paul, Minn.
9. Clark, G. L. *Applied X-Rays.* 1940, 3rd ed., McGraw-Hill Book Co., New York. Chapter 21.
10. Deschreider, A. R. Measuring of particle size of flour. Central Lab. Ministry Econ. Affairs, Brussels, Belgium, *Pub. No. 52*, 4 pp. (1950); *C. A.*, **44**, 8010f (1950).
11. Doty, D. M. American Meat Institute Foundation, The University of Chicago, Chicago, Ill. (Personal communication.)
12. Dunn, E. J. Jr. Microscopic measurements for the determination of particle size of pigments and powders. *Ind. Eng. Chem., Anal. Ed.*, **2**, 59-62 (1930).
13. Federal Specification: Apricots, Evaporated, or Dried, Z-A-636b, 7 Feb. 1946.
14. Federal Specification: Barley, Pearl, N-B-121z, 26 Oct. 1950.
15. Federal Specification: Cereals, Breakfast; Prepd., Ready-to-Eat, N-C-196c, 13 Jan. 1953.
16. Federal Specification: Cereals, Wheat; Uncooked, N-C-201, 20 Aug. 1952.
17. Federal Specification: Sieves, Standard, Testing, RR-S-366z, 29 Apr. 1942.
18. Federal Specification: Sugar, Beet or Cane, JJJ-S-791a, 20 Feb. 1943.
19. Ferrarese, C. J., Capt. QMC, and Put, E. B., Capt. QMC, Quartermaster Subsistence School, Chicago Quartermaster Depot, Chicago, Ill. (Personal communication).
20. Frederick, E. Measurements, by flow birefringence, of the size of denatured egg albumin particles. *Bull. Soc. Chem., Belges*, **56**, 223-7 (1947); *C. A.*, **42**, 1973i (1948).
21. Gamble, D. L., and Barnett, C. E. Scattering in the near infrared; a measure of particle size and size distribution. *Ind. Eng. Chem., Anal. Ed.*, **9**, 310-14 (1937).
22. Gooden, E. L., and Smith, C. M. Measurement of average particle diameter of powders. *Ind. Eng. Chem., Anal. Ed.*, **12**, 479-82 (1940).
23. Goodhue, L. D., and Smith, C. M. The particle size of insecticidal dusts; a new differential manometer-type sedimentation apparatus. *Ind. Eng. Chem., Anal. Ed.*, **8**, 469-72 (1936).
24. Green, H. Photomicrographic method for the determination of particle size of paint and rubber pigments. *J. Franklin Inst.*, **192**, 637-66 (1921).
25. Grey, V. R. Surface films and particle size determinations of powders. *Can. J. Research*, **28B**, 277-91 (1950).
26. Grossman, N. Determination of grain size by ultrasonics. *Iron Age*, **172**, No. 27, 72-5 (1953); *C. A.*, **48**, 2445c (1954).
27. *Hackh's Chemical Dictionary.* The Blakiston Co., Philadelphia, Pa., 3rd Ed., 1946 Printing.
28. Hauser, E. A., and Lynn, J. E. Separation and fractionation of colloidal systems. *Ind. Eng. Chem.*, **32**, 659 (1940).
29. Jacobs, M. B. *The Chemistry and Technology of Food and Food Products.* 1949, Vol. II, Interscience Publishers, Inc., New York.
30. Kane, J. N. *Famous First Facts.* 1950, the H. W. Wilson Company, New York.
31. Kelly, W. J. Determination of distribution of particle size. *Ind. Eng. Chem.*, **16**, 928-30 (1924).
32. Kimball, L. B., Kertesz, Z. I. Practical determination of size distribution of suspended particles in macerated tomato products. *Food Technol.*, **6**, 68-71 (1952).
33. Lindemann, E. Determination of the granule sizes of starches. *Die Stärke*, **2**, 228-33 (1950; *C. A.*, **45**, 8871f (1951).
34. "Methods for the Use of B. S. Fine-Mesh Test Sieves." British Standards Inst., London, B.S. 1796:1952.
35. *Methods of Analysis.* 1950, 7th ed., Association of Official Agricultural Chemists, Washington, D. C.
36. Military Specification: Cocoa Beverage Powder, Mil-C-3031, 30 Aug. 1949.
37. Military Specification: Cookies, Sandwich, Mil-C-1043B, 31 July 1953.
38. Military Specification: Fruitcake, Fresh, and Fruitcake, Canned, Mil-F-3232B, 8 May 1953.
39. Military Specification: Soup, Pea, Precooked, Dehydrated, Mil-S-3686, 28 Jan. 1952.
40. Norton, F. H., and Speil, S. The measurement of particle size in clays. *J. Am. Ceram. Soc.*, **21**, 89 (1938).
41. Paneth, F. *Radio Elements as Indicators.* 1928, McGraw-Hill Book Co., New York.
42. Paneth, F. Method for the determination of surface of adsorbing powders. *Z. Elektrochem.*, **28**, 113-5 (1922).
43. Paneth, F., and Vorwerk, W. Thickness of the adsorbed layer in the adsorption of dyes in crystals. *Z. Physik. Chem.*, **101**, 480-8 (1922).
44. Parr, S. W., and Staley, W. D. Determination of sulfur by means of the turbidimeter. *Ind. Eng. Chem., Anal. Ed.*, **3**, 66 (1931).
45. *Proc. Am. Soc. Testing Materials*, **32**, Pt. II, 607 (1932).
46. Salt Lake Stamp Company, Salt Lake City, Utah.
47. Sloan, C. K. Unpublished paper presented at 125th National ACS Meeting, reported in *Chem. Eng. News*, **32**, 1443 (1954).
48. Swedberg, T. Colloid Chemistry. American Chem. Soc. Monograph (1928).
49. *The Canned Food Reference Manual.* 1949, 3rd ed., American Can Company, New York.
50. *The Handbook of Measurement and Control.* The Instruments Publishing Co., Inc., Pittsburgh, Pa., 1951.
51. *Ibid.*, p. 200.
52. "The Profitable Use of Testing Sieves." W. S. Tyler Co., Cleveland, Ohio. Catalogue 53, 1952, p. 14.
53. *Ibid.*, p. 38.
54. *Ibid.*, p. 40.
55. *Ibid.*, p. 54.
56. *Ibid.*, pp. 12-14, 51.
57. *Ibid.*, pp. 18-25, 52, 53.
58. U. S. Bureau of Mines, Report of Investigation **3333**, 39-51 (1937).
59. U. S. D. A. Standards for Grades of Canned Beets, 9 June 1948.
60. Watson, J. H. L. Particle-size determinations with electron microscopes. *Anal. Chem.*, **20**, 576-84 (1948).
61. Weber, M. Jr., and Moran, R. F. A precise method for sieving analyses. *Ind. Eng. Chem., Anal. Ed.*, **10**, 180-4 (1938).
62. Winton, A. L., and Winton, K. B. *The Analysis of Foods.* 1945, John Wiley & Sons, Inc., New York.
63. Witte, M. Rapid determination of particle size in wheat flour. *Muhlenlab.*, **6**, 33-6 (1936).
64. Woodman, A. G. *Food Analysis.* 1941, 4th ed., McGraw-Hill Book Co., Inc., New York.
65. "Woven Wire Screens." W. S. Tyler Co., Cleveland, Ohio, Catalogue 70, p. 159.
66. Zijlstra, K. Potato starch flour. Verslag Landb. Onderzrek No. 47A, 1223-74 (1941); *Chem. Zentr.*, 1942, II, 2212-13; *C. A.*, **38**, 2401[1] (1944).

# The Effects of Iodized Salt in Processed Fruits and Vegetables[a]

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(Manuscript received June 28, 1954)

Endemic goiter is prevalent in many parts of the world *(1)* in spite of the fact that Boussingault (1824) and Chatin (1850) concluded that a deficiency of environmental iodine was definitely associated with the occurrence of goiter *(2)* and the further fact that endemic goiter is considered to be the easiest known disease to prevent *(4, 5, 6, 7, 8)*. Even in the United States, where considerable publicity has been given to the use of iodized salt for the prevention of the disease, the incidence of simple goiter may be as high as 1.4% among children in the goiter belt *(3)*. Failure to utilize iodized salt is probably a factor in this situation; a survey by means of telephone calls and personal visits revealed, for example, that only 50% of the salt sold in Columbus, Ohio, is iodized salt. Since the general use of iodized salt in widely used processed foods would appear to be an additional safeguard against endemic goiter, a study of its effects on processed foods warrants further investigation.

This paper presents the results of tests designed to evaluate the effects of added iodine on the quality including the palatability of some processed vegetables and fruit. Iodates $KIO_3$ (the Department of Health, Education, and Welfare does not permit the use of $KIO_3$ in salt) were included to learn whether or not this supposedly more stable form of iodine could be used in place of the usual KI. Cuprous iodide was also tested in a limited way to se if this relatively insoluble form (a type desired for use with livestock) had any deleterious effect on Vitamin C.

## EXPERIMENTAL PROCEDURE

**Tomato juice.** *Preparation of Solutions:* Eleven stock solutions, each containing 259.2 g. (amount which supplies salt at rate of 60 grains per No. 2 can of tomato juice) of NaCl and, in addition, the chemicals noted below were prepared and made up to one liter with distilled water the night prior to use. All chemicals were of c.p. quality. To secure iodine equal to that in commercial iodized salt 0.026 g. of KI and 0.034 g. of $KIO_3$ were used in each liter. Concentrations of 0.26 g. of KI were also used. Sodium nitrate or $NaNO_3$ at the rate of 3.866 g. per liter to give a concentration of 0.01% in the tomato juice.

**Processing techniques.** Tomatoes of the Rutgers variety were washed, trimmed, cored, and extracted twice in a Langsenkamp laboratory model extractor. The second extractions were combined. The mixture was then pumped through a Walker Wallace heat exchanger where it was held for 2½ minutes at 240° F. The flash sterilized tomato juice flowed directly into No. 2 fruit enamel cans which had previously received 15 ml. of one of the prepared chemical solutions. The uniformly filled cans were then sealed in an atmosphere of steam to insure a higher vacuum. The canned juices were kept at room temperature for about 3 months before the products were evaluated.

**Cabbage.** *Fermentation.* The Bugner variety was harvested early in October and wilted for a few days at room temperature. The outer leaves and core were removed by hand, and the leaves were shredded by a laboratory model kraut cutter. Fifteen pounds of the shredded cabbage were weighed and packed very tightly into glazed crocks. In packing, sufficient salt was added to give a concentration of 2.5%. At the same time, 15 ml. of distilled water were added to the controls. For the iodized and iodated salt batches, 0.0205 g. of KI and 0.0265 g. of $KIO_3$ were added in solution. This is an amount equivalent to that secured by using iodized salt containing 0.012% KI.

During the fermentation, the acidity was checked every 3 days. All lots were allowed to ferment for thirty-one days at room temperature. At the end of the fermentation, samples (10 ounces per sample) of each lot of kraut were packed in polyethylene bags. These samples were stored at 35° F. for 2 days before being evaluated by the panel. The rest of the kraut was canned.

**Canning.** After weights were removed from the kraut, the discolored upper layer of kraut was thrown away. The remaining kraut was transferred to a cheesecloth, and the juice extracted by a slight pressure.

The acidity of the juice was determined and adjusted to one percent by the addition of a calculated amount of distilled water. Salt concentration was determined on the adjusted juice chemically and by salometer readings. The salt concentrations were found to be the same, and therefore, no adjustment was made. The adjusted juice was brought to boiling.

The kraut was steamed at 214° F. for 5 minutes, weighed and packed into plain tin cans. Kraut juice at 210° F. was used to cover the kraut in the cans.

The canned lots were exhausted for 5 minutes in steam, sealed and processed at 214° F. for 15 minutes. The processed kraut was cooled immediately in running water. After being cooled down to room temperature, the lots were stored at room temperature for about 2 months before the evaluations.

**Green beans.** The freshly harvested Hyscore green beans were washed in a spray rotary washer, inspected on a moving belt for defects, and graded into sizes No. 5 and No. 6 ($^{24}/_{64}$ in. or more in thickness). They were then cut into pieces 1½ to 2 inches in length.

The cut beans were blanched at 212° F. in steam for 5 minutes, cooled immediately in running water, drained, and 0.66 lbs. weighed into No. 2 cans, with 30 grains (1.944 g.) of either plain or iodized salt[b] added. Boiling distilled water was added to the packed cans to fill, but not to overflowing. They were exhausted for four minutes in steam. Upon emerging from the exhaust box, the cans were sealed and processed at 240° F. for 20 minutes. After processing, they were immediately cooled by circulating cold water and stored at room temperature for about three months.

**Yellow sweet corn.** The Golden Cross Bantam ears were harvested and brought into the processing laboratory immediately; they were husked by a FMC (Food Machinery Co.) husker. The defects were removed, and whole kernels were cut by a FMC No. 2 Universal corn cutter. The kernels were washed by a high pressure spray rotary washer and blanched in steam for three minutes. After being cooled in cold water 13.5 oz. of kernels were packed in No. 2 C-enamel cans with 30 grains of either plain salt or iodized salt. A boiling sugar solution, which contained 3.5 pounds of sugar in 10 gals. of water, was then added.

[a] A contribution of the Department of Horticulture and the Institute of Nutrition and Food Technology of The Ohio State University. Financed by contributions from the Chilean Iodine Educational Bureau, Inc., and Kelvin Smith.

[b] The iodized salt used (Morton) contains a maximum of 112 p.p.m. of KI.

The corn was exhausted for 3 minutes, sealed by a closing machine in a head of steam, processed at 250° F. for 30 minutes, and cooled immediately in running water; it was stored at room temperature for about 3 months.

**Pickled olives.** The pitted pickled olives from Spain were stuffed with pieces of red pimientos. The olives were washed and packed at the Kroger Company's plant, Cincinnati, Ohio, in a brine solution in glass jars. The following formula was used:

| | |
|---|---|
| Salt | 350 pounds |
| Lactic acid (50%) | 67.5 pounds |
| Water to make | 570 gals. |

For the iodized salt brine 0.0335 g. of KI was dissolved in a gallon of the above brine, to give 0.02% of KI. For iodated salt brine, 0.0502 g. of $KIO_3$ (equivalent amount of 0.0335 g. of KI cited above) was dissolved in a gallon of the brine.

The pickled olives were packed in the above three kinds of brines in glass bottles and sealed while the head space was steam filled. The bottled olives were stored at room temperature for about 2 months.

**Flavor evaluation.** *Numerical Scoring.*[1] The flavors of canned tomato juices and bulk and canned kraut were scored from one to 10 (10 being the best) by the experienced panel. A control sample was known to the judges, and they were told to check the other samples against it. An identical unknown sample was also included to check the judges. The judging on a group of samples was repeated at different intervals.

*Triangle Test.*[1] Triangle tests were also conducted to see whether there is any detectable differences between the controls and iodized or iodated salt-treated samples.

*Dilution Tests.* Six samples of tomato juice containing increasing amounts of iodine were served. Judges were asked to check the first sample in the series in which they detected an off-flavor.

**Color determination.** Panel grading of color was used only in the case of bulk kraut, where the subjective numerical scoring by the judges was used to evaluate color differences between the treatments.

*The Hunter Color Difference Meter.* Differences in color of the tomato juices and the canned sauerkraut were measured by the Hunter instrument. A small aperture with a small area illumination with "L" scale was used for the tomato juice. A large aperture and large area illumination with "Rd" scale was used for evaluating the color of sauerkraut.

*Subjective Texture and Color Evaluations.* The flavor and odor evaluations of the canned tomato juices and sauerkraut were scored numerically from one to 10. Texture was also evaluated numerically in the same way on the same score card for sauerkraut.

**Ascorbic acid determination.** Ascorbic acid contents of the tomato juices and the fresh and canned green beans were determined by the indophenol titration method of the A. O. A. C. with the following modifications: One percent oxalic acid was used in place of one percent metaphosphoric acid. Homogenization was eliminated in the case of tomato juice, and instead the weighed juices were transferred into 200-ml. volumetric flasks with the oxalic acid, mixed well, made up to volume, mixed again, and filtered.

## RESULTS AND DISCUSSION

**Flavor evaluation.** *Canned Tomato Juice.* The average scores of treated tomato juice are shown in Table 1.

Table 2 shows the results of analysis of variance.

As seen from Table 2, the judges could not find a significant difference in the flavor of the canned tomato juices due to the addition of iodized or iodated salt. Even ten times as much KI or $I_2$ failed to produce any distinguishable off-flavor.

[1] In both numerical scoring and triangle tests, the containers used for tomato juices were 10 ml. clean glass beakers; for other samples, shallow white china dishes of about 5 inches in diameter were used.

**TABLE 1**

**Average scores of 16 judgings of flavor of canned tomato juices**

| Chemicals added | Average score |
|---|---|
| Control | 8.3 |
| KI | 7.4 |
| $KI_3$ | 8.0 |
| KI and $NaNO_3$ | 7.6 |
| KI and $NaNO_2$ | 7.7 |
| $KIO_3$ and $NaNO_3$ | 7.1 |
| $KIO_3$ and $NaNO_2$ | 7.7 |
| KI × 10 and $NaNO_3$ | 7.8 |
| KI × 10 and $NaNO_2$ | 7.4 |
| $I_2$ | 7.6 |
| $I_2$ × 10 | 7.0 |

**TABLE 2**

**Analysis of variance of flavor evaluation of canned tomato juice**

| Source | DF | SS | MS | F | F (.05) | F (.01) |
|---|---|---|---|---|---|---|
| Treatments | 11 | 20.552 | 1.87 | 1.53 | 1.84 | 2.36 |
| Judges | 15 | 292.365 | 19.49 | 15.97** | 1.73 | 2.16 |
| Error | 165 | 201.198 | 1.22 | | | |

** Highly signifiant difference.

The effect of iodized salt in the presence of considerable amounts of nitrite or nitrate on tomato juice flavor seems to be negligible.

**Color evaluation.** The "a" and "b" readings on the Hunter Color Difference Meter were repeated 3 times. The resulting "a/b" ratios were combined and the average values are shown in Table 3.

**TABLE 3**

**The "a/b ratios" of tomato juice (three replicates)**

| Treatment | Replicates | | | Average |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| Control | 1.65 | 1.78 | 1.72 | 1.71 |
| KI | 1.63 | 1.78 | 1.72 | 1.71 |
| $KIO_3$ | 1.63 | 1.74 | 1.76 | 1.71 |
| KI and $NaNO_3$ | 1.71 | 1.87 | 1.81 | 1.79** |
| KI and $NaNO_2$ | 1.56 | 1.78 | 1.74 | 1.69 |
| $KIO_3$ and $NaNO_3$ | 1.69 | 1.78 | 1.74 | 1.73 |
| $KIO_3$ and $NaNO_2$ | 1.63 | 1.78 | 1.74 | 1.71 |
| KI × 10 and $NaNO_3$ | 1.66 | 1.78 | 1.76 | 1.73 |
| KI × 10 and $NaNO_2$ | 1.55 | 1.78 | 1.76 | 1.69 |
| $I_2$ | 1.66 | 1.81 | 1.81 | 1.76 |
| $I_2$ × 10 | 1.68 | 1.81 | 1.81 | 1.76 |

** Significantly different from the control at 5% level (L.S.D. 5% —0.97; 1% —0.096).

Though there was a highly significant difference in "a/b" ratio between the treatment receiving (KI + $NaNO_3$) and the control, it is important to note that the average score of the treated lots is higher than that of the control.

Iodized salt thus did not adversely affect the color of tomato juice.

**Odor.** Odor of the canned tomato juices was evaluated subjectively from 1 to 10.

Table 4 shows the average scores of the seven judges. It shows that the judges could not detect any significant difference in odor between the treatments.

**Ascorbic acid.** Ascorbic acid determinations on the 11 treatments were also repeated 3 times.

Table 5 shows the average values of the 3 determinations of ascorbic acid for the 11 lots of canned tomato juice.

From Table 5 it can be seen that 3 nitrite treatments had but half the reduced ascorbic acid content of other treatments including the controls.

*Tests with Cuprous Iodide.* Relatively insoluble cuprous iodide was added to 2 samples of tomato juice at the rate of 0.01%. One lot was agitated for 5 minutes with a Waring blender and the other by pouring the juice 40 times from one tin can to another. The check and CuI treated lots agitated by pouring, both contained

**TABLE 4**
**The average scores of seven judges evaluating odor of the eleven treatments of canned tomato juices**

| Treatment | Aerage score of judges |
|---|---|
| Known control | 8.50 |
| Unknown control | 8.50 |
| KI | 8.50 |
| $KIO_3$ | 8.63 |
| KI and $NaNO_3$ | 8.63 |
| KI and $NaNO_2$ | 8.50 |
| $KIO_3$ and $NaNO_3$ | 8.50 |
| $KIO_3$ and $NaNO_2$ | 8.63 |
| KI × 10 and $NaNO_3$ | 8.50 |
| KI × 10 and $NaNO_2$ | 8.63 |
| $I_2$ | 8.50 |
| $I_2$ × 10 | 8.63 |

**TABLE 5**
**The average values of three ascorbic acid determinations of the canned tomato juices**

| Treatment | Average amount of reduced ascorbic acid (mg./100 grams) |
|---|---|
| Control | 22.50 |
| KI | 24.00 |
| $KIO_3$ | 23.40 |
| KI and $NaNO_3$ | 23.33 |
| KI and $NaNO_2$ | 10.44** |
| $KIO_3$ and $NaNO_3$ | 23.93 |
| $KIO_3$ and $NaNO_2$ | 9.73** |
| KI × 10 and $NaNO_3$ | 23.46 |
| KI × 10 and $NaNO_2$ | 10.63** |
| $I_2$ | 23.46 |
| $I_2$ × 10 | 24.00 |

** Highly significant differences (L. S. D. 5% —5.35; 1% —7.27).

21.5 mg. ascorbic acid per 100 g. and the check agitated by the Waring blender contained 18.4 and the CuI treated lot 18.0 mg. ascorbic acid per 100 g.

**Triangle test.** Canned tomato juice containing a commercial salt and another containing a commercial iodized salt were subjected to a triangle test to see whether the judges could distinguish between iodized and non-iodized tomato juices.

On two occasions the 8 judges were given 3 samples of tomato juices, 2 of which were identical. They were asked to identify the identical two, and the number of correct answers were interpreted statistically to see if there were any significant difference between the 2 treatments. The table prepared by Rosseler *et al. (10)* was used to analyze the data.

The 2 judgings were combined, and the results in Table 6 show clearly that the judges could not detect any difference between iodized and non-iodized salt-

**TABLE 6**
**Analysis of the results of triangle taste tests on iodized and non-iodized canned tomato juices**

| No. of tastings | No. of correct answers | No. of correct answers necessary to establish significant difference | |
|---|---|---|---|
| | | P.05 | P.01 |
| 16 | 3 | 10 | 11 |

treated tomato juices. If there were difference in any of the qualities which can be detected subjectively, i.e., flavor, odor, and color, they should have been detected by the panel.

To get an idea how much iodine must be present to impart a detectable off-flavor to the tomato juices, a concentration test was conducted on the canned tomato juice to which increased amounts of iodine were added.

Eight judges participated in the test, and the results are shown in Table 7.

**TABLE 7**
**The results of concentration tests on different concentrations of iodine in canned tomato juices**

| Concentration of $I_2$ in canned tomato juice (p.p.m.) | No. of tasters who detected an off-flavor |
|---|---|
| 0.000 | 0 |
| 0.625 | 0 |
| 2.500 | 0 |
| 6.250 | 0 |
| 12.500 | 1[1] |
| 25.000 | 2 |

[1] The judge stated that he tasted this as slightly different from the preceding concentrations but would not call it off-flavor.

The iodine concentration of canned tomato juice, in which iodized salt is used, is about 0.5 p.p.m. From the Table 7, therefore, it may be said that even at the level of 12.5 p.p.m. (25 times as much iodine as in ordinary iodized tomato juice), iodine failed to impart any appreciable off-flavor to tomato juice.

*Bulk and Canned Sauerkraut.* The results of the acid determinations made every 3 days while the cabbage was fermenting are shown in Table 8.

**TABLE 8**
**Acidity produced by sauerkraut fermentation treated with iodized and iodated salts (acidity expressed as percent lactic acid)**

| Treatment | Days of fermentation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7 | 10 | 13 | 16 | 19 | 22 | 25 | 28 | 31 |
| Control-1 | 0.88 | 1.20 | 1.40 | 1.52 | 1.44 | 1.48 | 1.52 | 1.60 | 1.68 |
| Control-2 | 0.84 | 1.01 | 1.22 | 1.43 | 1.56 | 1.60 | 1.65 | 1.70 | 1.71 |
| Iodized-1 | 0.77 | 1.05 | 1.19 | 1.30 | 1.38 | 1.50 | 1.60 | 1.65 | 1.70 |
| Iodated-2 | 0.78 | 1.00 | 1.16 | 1.33 | 1.51 | 1.56 | 1.60 | 1.68 | 1.75 |
| Iodated | 0.88 | 1.21 | 1.45 | 1.56 | 1.64 | 1.68 | 1.71 | 1.73 | 1.78 |

The data indicate no appreciable effects from the use of iodized or iodated salts on the acid formation during kraut fermentation.

**Flavor evaluation.** *Bulk Kraut.* Since the total acidities of the 2 control samples were slightly different it was deemed essential to evaluate each by taste panels. The results are shown in Table 9.

**TABLE 9**
**The average scores of eight judges evaluating flavor of bulk kraut using Control-1 as a check**

| Treatment | Average scores of eight judges |
|---|---|
| Control-1 (known) | 7.60 |
| Control-1 (unknown) | 6.60 |
| Control-2 | 6.90 |
| Iodized-1 | 7.00 |
| Iodized-2 | 6.70 |
| Iodated | 7.30 |

The judges failed to detect any significant differences between samples.

*Canned Kraut.* The differences in flavors of the canned kraut were evaluated subjectively after two months' storage at room temperature. The results obtained show that in both cases, using control-1 or control-2 as a check, no significant difference in flavor could be detected between the lots of canned kraut. In other words, the use of iodized or iodated salt in sauerkraut failed to produce any significant detectable off-flavors.

*Bulk Kraut.* Color differences between the lots of bulk kraut were scored subjectively. The judges could not detect any difference in color due to the presence of iodized or iodated salts.

*Canned Kraut.* In the case of canned kraut, "a" readings on "$R_d$" scale of the Hunter Color Difference Meter were taken as objective measures of color. The "a" values were exactly the same for all the lots, i.e., 58. It is safe to conclude that iodized or iodated salts can be used without producing any changes in kraut color.

*Bulk Kraut.* The textures of both bulk and canned kraut were scored subjectively from 1 to 10. The average scores of judges are given in Table 10.

**TABLE 10**
**The average scores of eight judges scoring texture of bulk kraut using Control-2 as a check**

| Treatment | Average scores |
|---|---|
| Control-2 (known) | 8.20 |
| Control-2 (unknown) | 7.60 |
| Control-1 | 6.60 |
| Iodized-1 | 7.60 |
| Iodized-2 | 7.70 |
| Iodated | 8.00 |

It may be concluded that the judges could not detect any significant effects of iodized or iodated salt on the texture of bulk kraut.

*Canned Kraut.* The texture of the canned kraut was also evaluated subjectively. Table 11 shows the average scores of the judges using different controls as a check on texture of the canned kraut.

**TABLE 11**
**The average scores of eight judges scoring texture of canned kraut using Control-1 as a check**

| Treatment | Average scores |
|---|---|
| Control-1 (known) | 7.63 |
| Control-1 (unknown) | 7.38 |
| Control-2 | 7.63 |
| Iodized-1 | 8.00 |
| Iodized-2 | 7.63 |
| Iodated | 7.88 |

From this and other data, we can conclude that neither iodized nor iodated salt induced any deterioration in the texture of canned kraut.

**Odor evaluation.** The judges scored odor subjectively.

The results in Table 12 show that the judges could not detect any different or undesirable odor due to the use of iodized or iodated salts in canned sauerkraut.

*Canned Green Beans.* Since only two lots of canned green beans were prepared, i.e., with iodized salt and plain salt, the triangle test was used to detect differences in flavor, texture, odor, or color. The results of the 2 triangle tests were combined and are shown in Table 13.

These results show that there was no difference in flavor, color, texture, or odor which may have been utilized in identifying the duplicates.

**Ascorbic acid.** The amounts of reduced ascorbic acid found in the beans in 6 different cans are shown in Table 14.

**TABLE 12**
**The average scores of eight judges scoring odor of canned kraut using Control-1 as a check**

| Treatment | Average scores |
|---|---|
| Control-1 (known) | 8.00 |
| Control-2 (unknown) | 8.00 |
| Control-2 | 7.75 |
| Iodized-1 | 7.38 |
| Iodized-2 | 7.63 |
| Iodated | 7.75 |

**TABLE 13**
**Results of triangle test of canned green beans stored for three months at room temperature**

| No. of judgings | No. of correct answers | No. of correct answers necessary to establish significant difference | |
|---|---|---|---|
| | | 5% | 1% |
| 14 | 1 | 9 | 10 |

**TABLE 14**
**The amount of ascorbic acid in canned green beans after three months' storage at room temperature (expressed in mg./100 g. of juice)**

| Replicate | Control | Iodized salt |
|---|---|---|
| 1 | 4.75 | 4.75 |
| 2 | 5.13 | 4.94 |
| 3 | 4.81 | 4.90 |
| Average | 4.89 | 4.86 |

Without resorting to analysis of variance, it is obvious that the results show no effect of iodized salt on the ascorbic acid content of canned green beans.

*Canned Yellow Corn.* Triangle tests failed to find any detectable differences in flavor or color between iodized and plain salted, canned, yellow, whole kernel corn.

**TABLE 15**
**Result of two triangle tests using different treatments as duplicate in canned whole kernel yellow corn stored for three months at room temperature**

| No. of judgings | No. of correct answers | No. of correct answers necessary to establish significant difference | |
|---|---|---|---|
| | | 5% | 1% |
| 16 | 5 | 10 | 11 |

*Pickled Olives.* Since pickled olives were treated three ways, i.e., plain-salted, iodized-salted, and iodate-salted, 4 judgings were made. The results of the triangle tests are shown in Tables 16 and 17.

**TABLE 16**
**Result of triangle test on iodized-salted and plain-salted olives**

| No. of judgings | No. of correct answers | No. of correct answers necessary to establish significant difference | |
|---|---|---|---|
| | | 5% | 1% |
| 15 | 4 | 9 | 10 |

**TABLE 17**
**Result of triangle test on iodated-salted and plain-salted olives**

| No. of judgings | No. of correct answers | No. of correct answers necessary to establish significant difference | |
|---|---|---|---|
| | | 5% | 1% |
| 15 | 4 | 9 | 10 |

The results again show that the judges could not find any detectable differences between plain-salted and iodized-salted or iodated-salted bottled pickled olives.

## CONCLUSIONS

In conclusion, the results obtained in this work all show no detectable deterioration in quality due to use of iodated or iodized salt in canned tomato juice, bulk and canned sauerkraut, canned green beans, canned whole kernel yellow corn, and bottled pickled olives.

Since the products tested were representative of processed fruits and vegetables which contained considerable amounts of salt, it may be concluded that as far as processed fruits and vegetables are concerned, there will be no fear of deterioration of the quality of products due to the use of iodized salt instead of plain salt.

Therefore, it would seem wise to use iodized salt in processing vegetables and fruits to reduce the incidence of goiter. It might even be wise to state on the label that iodized salt had been added as an additional safeguard to health.

## LITERATURE CITED


1. Anonymous. Goiter a world-wide disease. (Fact No. 335, from pamphlet of the Iodine Educational Bureau, Stone House, Bishopsgate, London, 1946.)
2. Anonymous. Environmental iodine deficiency. (Fact No. 305 and Fact No. 340, *ibid.*, Iodine Educational Bureau, Stone House, Bishopsgate, London, 1946.)
3. Anonymous. Michigan Dept. of Health, E-1, 1953.
4. Kimball, O. P. The efficiency and safety of the prevention of goiter. *J. Am. Med. Assn.*, **82**, 1328 (1924) and Olin, R. M. Iodine deficiency and prevalence of simple goiter in Michigan. Michigan Health Report, 21, 1924.
5. Marine, D., and Williams, W. W. The relation of iodine to the structure of the thyroid gland. *Arch. Int. Med.*, **1**, 349 (1908).
6. Marine, D. The occurrences and physiological nature of glandular hyperplasia of the thyroid. Johns Hopkins Hospital *Bull.*, **18**, 359 (1907).
7. Marine, D., and Lenhart, G. Further observations on the relation of iodine to the structure of the thyroid gland in the sheep, dog, and ox. *Arch. Int. Med.*, **3**, 66 (1909).
2. Marine, D., and Lenhart, C. Further observations and experiments on the so-called thyroid carcinoma of the brook-trout (Salva-linus Fontinalis) and its relation to endemic goiter. *J. Exp. Med.*, **13**, 455 (1911).
9. Nickerson, D. Color measurement and its application to the grading of agricultural products. U. S. Dept. Agr. *Misc. Publication 580*, 1946.
10. Roessler, E. B., Warren, J., Guymon, J. F. Significance in triangle taste test. *Food Research*, **13**, 6 (1948).


# The Effect of Aureomycin Treatment on the Shelf Life of Fresh Poultry Meat[a]


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Several recent studies report the effect of certain antibiotics in the preservation of canned goods. A few studies have been made to determine the preservative effect of antibiotics on fresh food products.

Tarr, Southcott and Bessett *(4)* conducted trials in which the preservation effect of fifteen antibiotics on fresh fish was studied. They found that aureomycin, terramycin and chloromycetin were consistently effective in delaying spoilage. Goldberg, Weiser and Deatherage *(2)* found that these same three antibiotics were the most effective of the six used to preserve fresh beef.

Kohler, Broquist and Miller *(3)* reported increases in shelf life of eviscerated and cut-up chicken of from 7 to 14 days when the meat was dipped into aureomycin solutions containing from 3 to 30 p.p.m. and then was stored at 40° F. (4.4° C.).

Since aureomycin was considered one of the most effective antibiotics in the studies mentioned above, it was used in this study of shelf life with fresh chicken fryers.

[a] Scientific paper No. 1358, Washington Agricultural Experiment Stations, Pullman; project No. 1076.

## EXPERIMENTAL METHODS

This study consisted of an experiment made up of three replicates which were not conducted simultaneously. Each replicate consisted of twelve fryers. The birds were dressed in the college poultry plant which is equipped with a Greenbriar Rotomatic Scalder and Greenbriar picker. Scalding was done in 128° F. (53.3° C.) water for forty seconds. The dressed birds were cooled for two hours in water containing melting ice, after which they were eviscerated and cut into halves. Four experimental treatments were applied on a half bird basis. The basic design was plan 11.1 of Cochran and Cox *(1)*, which is a balanced incomplete block design with the treatments in blocks of two and each treatment repeated three times. The possible replicate grouping was not utilized in the present instance. Each bird, being halved, formed a block of two treatments and thus possible bird to bird differences were removed from the treatment comparisons. Three runs of twelve fryers were utilized with the basic design being repeated within each run. Thus,

with six repetitions of the design, there were eighteen replications of each experimental treatment.

The four experimental treatments included a control (no treatment other than dressing and wrapping), and solutions of aureomycin into which the halves were dipped prior to wrapping. The 10, 20 and 40 p.p.m. solutions were made up with 8 liters of water and 80, 160, annd 320 mg. of aureomycin hydrochloride, respectively. In each case the six halves were immersed in the respective solutions simultaneously and allowed to remain for 10 minutes. After removal from the solutions, the halves were allowed to drain and were then packaged. This was done by placing the half birds on a cardboard "boat" (a flat tray-like cardboard receptacle) and then putting it into a polyethylene bag. After packaging, the half birds were refrigerated at 36° F. (2.2° C.).

Observations for spoilage were made daily after the sixth day. Spoilage was detected by the presence of slime and/or associated with spoilage odors. The presence of slime was determined by the slime smear method described by Ziegler, Spencer and Stadelman *(5)*. Odor and slime observations were made by the same person throughout this experiment.

## RESULTS AND DISCUSSION

It is noted that the treated halves in this experiment acquired an off odor differing from the typical off odor of the control halves of chicken. It was not so pronounced and was more difficult to identify. There was considerable difference between the time required for development of off odor of the control and the treated halves. The average days to off odor were 11.6, 17.6, 18.4 and 18.9 for controls and groups treated with 10 p.p.m., 20 p.p.m., and 40 p.p.m., respectively. Analysis of variance of these data indicate the differences to be highly significant.

Observations of the slime smears revealed that the microflora of the surface of the treated halves differed from that of the control halves. The predominant organisms on the treated halves were yeasts having the shape and budding characteristics of the family *Saccharomycetaceae*. On the controls the predominant organisms were gram negative rod shaped bacteria. In many instances on the halves treated with 10 p.p.m. aureomycin, a considerable number of the gram negative bacteria were present with the predominating yeasts.

Placing eviscerated chicken fryers in 10, 20 and 40 p.p.m. aureomycin solutions very significantly increased their shelf life. These results are similar to those obtained by Kohler, Broquist and Miller *(3)*, Tarr, Southcott and Bessett *(4)* and Goldberg, Weiser and Deatherage *(2)* who were studying the effect of antibiotics in the preservation of poultry, fish, and beef, respectively. Spoilage was observed earlier by the detection of slime than off odor.

## SUMMARY

Halves of chicken fryers were immersed for ten minutes in water solutions containing 10, 20 or 40 p.p.m. aureomycin prior to packaging. Shelf life of the poultry meat stored at 36° F. (2.2° C.) was increased from 8.7 to about 14 days by this treatment.

## LITERATURE CITED

1. Cochran, W. G., and Cox, G. M. Experimental designs, 1st ed., 1950. John Wiley & Sons, Inc., New York, N. Y.
2. Goldberg, H. S., Weiser, H. H., and Deatherage, F. E. Studies on meat. IV. The use of antibiotics in preservation of fresh meat. Food Technol., **7**, 165-166 (1953).
3. Kohler, Richard A., Broquist, Harry P., and Miller, W. H. Chlortetracyline and the control of poultry spoilage. *Food Technol.*, **8**, 19 abstract section (1954).
4. Tarr, H. L. A., Southcott, B. A., and Bessett, H. M. Experimental preservation of flesh foods with antibiotics. *Food Technol.*, **6**, 363-366 (1952).
5. Ziegler, Frank, Spencer, J. V., and Stadelman, W. J. A rapid method for determining spoilage in fresh poultry meat. *Poultry Sci.*, **33**, 1253-1255 (1954).

# Notes and Letters

## The Program of the Food Protection Committee of the National Research Council*

During the decade ending in 1950 numerous new chemicals came into use as pesticides or as functional additives. Development research was expanded. After the war ended and public pre-occupation with wartime exigencies ceased, it was possible to return to peacetime projects. Thus, the Food and Drug Administration hearings for the definitions and standards of identity for foods were resumed. These hearings emphasized the increased use of chemicals in food products. For example, the hearings on bread, which centered on certain new chemical agents being used, were reopened. These agents were contested as admissible ingredients when in the same decade the House of Representatives set up a select committee to investigate the use of chemicals in foods.

Prompted by these developments, the National Research Council, at the request of an organizing industry committee, established in 1950 the Food Protection Committee of the Food and Nutrition Board. This Committee was to serve as a fact-finding and advisory body for both government and industry. The organization of the Food Protection Committee and its relation to the National Research Council and National Academy of Science are as follows:

National Academy of Science
D. W. Bronk, President

| National Research Council | Div. of Biology and Agriculture |
|---|---|
| Wm. W. Rubey, Chairman | Paul Weiss, Chairman |

Food and Nutrition Board
L. A. Maynard, Chairman

Food Protection Committee

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|---|---|
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| Toxicology, L. A. Maynard | Food Technology, D. B. Hand |

Liaison Panel

Representatives of Contributing Industries (about 50)
Representative of Trade Association and Foundations (about 15)
Representatives of Governmental Agencies (about 10)
Representatives of Scientific and Technical Societies (about 10)

Financial support from food and chemical industries provides for a secretarial staff and travel funds for meetings of the Committee, but the members serve without compensation.

The major objective of the committee as an advisory group is to collect and evaluate pertinent facts concerning the safe use of chemical additives in foods, to encourage a progressive food industry and to give guidance to government. It is not concerned with legislation and in no way tends to influence legislation. This is neither an objective nor a function of the committee.

The committee is well aware that the problem confronting it relative to the use of chemicals in foods is a large one and has planned its program accordingly. The tentative program for 1954 may be outlined briefly as follows:

*General Objectives:*

1. To develop better criteria and methods for establishing the safety of food additives, i.e., a critical review of the basic principles *(5)*.

2. To encourage the kind of research programs necessary to meet the criteria developed under the basic principles.

3. To promote cooperation between industry and government in the development and control of chemical additives in foods.

*Contemplated Activities:*

1. Critical review and elaboration of basic principles for the evaluation of "safety," including the following problems:

   (a) The extent to which "safety" must apply to the abnormal as well as normal segments of the population.

   (b) The extent to which "safety" involves the nutritional contribution of food.

   (c) The extent to which procedures for appraisal of "safety" can be standardized.

2. The formulation of research and testing procedures which will most promptly and effectively elicit the information necessary for safety evaluation. This activity would include a critical review of toxicological technics and their relation to the determination of "hazard" as defined in the basic principles.

3. Evaluation of the safety of certain intentional additives selected according to one or more of the following criteria:

   (a) The additive poses a well defined problem in relation to the development of basic principles.

   (b) The additive is widely used or its use is increasing in processed foods (i.e., sucaryl and saccharin).

   (c) The additive presents some definite indications of significant biological activity related to its proposed use.

4. Continued advisory service to industry and government in cases of controversial problems.

### ACCOMPLISHMENTS TO DATE

The committee, in the period from its first meeting in September 1950, to September 1953, working through its Sub-Committees on Chemistry, Food Technology, Pesticides, and Toxicology, has:

1. Assembled and reported, a factual statement of justification for use of chemical additives *(5)*.

2. Developed guiding principles for the use of chemical additives, which are given in the following statements:

   (a) Basic principles involved in evaluating safety in the use of chemical additives, in foods.

   (b) Basic considerations involved in evaluating hazards encountered in the use of pesticides on foods.

* Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

(c) Basic considerations in the development of a new agricultural pesticide intended for use in connection with food production *(2)*.

3. Undertaken the evaluation of available evidence concerning the safety of certain emulsifying agents (mono- and diglycerides and polyoxyethylene stearates) *(3, 4)*.

4. Developed a compendium of analytical methods for aldrin and dieldrin, benzene hexachloride, chlordane and heptachlor, and DDT *(1)*.

5. Collected factual information concerning the use of chemical additives in foods.

It has been stated, although not verified, that over 700 chemicals are used in foods. A survey has been made to obtain reliable information concerning the extent, purpose, and need for use of chemicals in foods. Thus far, information has been collected from most segments of the food industries, aside from those concerned with packaging agents. The data obtained are summarized in Tables 1 and 2.

**TABLE 1**

**Chemical additives currently used in foods by types**

| | |
|---|---|
| Preservatives, antioxidants, etc. | 36 |
| Emulsifiers, stabilizers, etc. | 48 |
| Bleaches, improvers, maturing agents, etc. | 27 |
| Buffers, acidulents, alkalis, etc. | 43 |
| Food colors | 21 |
| Artificial sweeteners | 3 |
| Vitamins and minerals (nutrients) | 43 |
| Miscellaneous anti-caking agents, etc. | 25 |
| Flavors | 49[1] |
| Packaging agents | Not Surveyed |
| Total number of chemicals ascertained | 295 |

[1] Represents only the more important flavors.

Of the chemicals indicated, 11 were cations, 35 anions and 151 esters or essential oils. Two hundred and eighteen chemicals have been mentioned as possible food additives but there is no evidence of their use. They are summarized in Table 2.

The project thus far has yielded valuable data that may be used to adduce responsible evidence concerning the number and purpose of chemicals in foods, as well as to estimate the possible hazards and benefits to public health.

The present objective is to publish the *Survey of Food Chemical Additives* as a means of establishing the facts about food chemicals and their use. Before publication, however, the report will be checked by the Food Protection Committee, the Industry Committee, the Food and Drug Administration, and the Meat Inspection Service for errors of omission and commission. If permission can be obtained, information of a confidential nature supplied by the Food and Chemical Industries will be published.

**TABLE 2**

**Numbers of possible food additives by types**

| | |
|---|---|
| Preservatives, antioxidants, etc. | 126 |
| Emulsifiers, stabilizers, etc. | 40 |
| Bleaches, improvers, maturing agents, etc. | 26 |
| Food colors | 2 |
| Artificial sweeteners | 2 |
| Vitamins and minerals (nutrients) | 5 |
| Miscellaneous anti-caking agents, etc | 13 |
| Flavors | Survey still in progress |
| Packaging agents | Not surveyed |
| Total number of chemicals mentioned but not used | 218 |

The published report will contain a preface indicating its preliminary and continuing nature and emphasizing that the listing of a chemical does not imply endorsement, approval, or that its safety has been established. Finally, a statement indicating the technological need and benefits of each of the groups of chemicals will be included.

**Acknowledgments**

The writer is indebted to W. Robinson and L. Voris for their assistance in the preparation of this paper. Neither the chairman of the committee, Dr. W. I. Darby, nor the Vice-Chairman, Dr. D. B. Hand, were able to present the paper due to assignments overseas and hence, acting as a substitute for Dr. Hand, the presentation was made by the author.

## LITERATURE CITED

1. National Research Council. *Annotated Bibliography of Analytical Methods for Pesticides.* Section 1, Pub. No. 241 (1952).
2. National Research Council. *Safe Use of Chemical Additives in Foods.* (1952).
3. National Research Council. *The Safety of Mono- and Diglycerides for Use as Intentional Additives in Foods.* Pub. No. 251 (1952).
4. National Research Council. *The Safety of Polyoxyethylene Stearates for Use as Intentional Additives in Foods.* Pub. No. 280 (1953).
5. National Research Council. *Use of Chemical Additives in Foods.* (1951).

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# THE TWINS THAT WIN:

Fragrance

Flavor

BOTH FOUND IN ONE PRODUCT

## ZIMCO® Vanillin

*The Original Lignin Vanillin*

**ZIMCO's outstanding excellence and uniformity of flavor are the result of its exclusive, patented manufacturing process . . . developed through years of scientific experiment and research.**

**Remember . . . your best source of finished, ready-to-use flavors is your flavor manufacturer. Ask him about ZIMCO, the *Original* pure Lignin Vanillin. *There's nothing finer.***

**Zimco Vanillin is noted for Quality and Dependability.**

*Consult Your Flavor Supplier*

Sterwin Chemicals INC.
SUBSIDIARY OF STERLING DRUG INC.

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**WORLD'S LARGEST SUPPLIERS OF VANILLIN**

Shipments direct from plant, Rothschild, Wisc.
Emergency deliveries from: Atlanta, Dallas, Evanston (Ill.), Los Angeles, Portland (Ore.), Rensselaer (N.Y.), St. Louis and San Francisco

*Diamond Crystal Alberger Salt is*

# America's largest-selling High-Grade* salt

*because...*

the exclusive Diamond Crystal Alberger System produces:

**Purity**—99.95% Sodium Chloride.

**Uniformity**—maximum purity variation ±0.01% . . . screened to a standard for each food product.

**Cleanliness**—lowest insolubles of any commercial grade of salt.

**Low heavy metals**—less than 1.5 part per million of pro-oxidants copper or iron.

**The premium grade salt used by food processors.*

**FOOD TECHNOLOGIST AT YOUR SERVICE**

For free consultation on choice and application of the right salt for your food products—call, wire or write:

**Technical Service Dept. B**
**Diamond Crystal Salt Co.**
**St. Clair, Michigan**
**Phone—296**

## Recently Elected Members of IFT

(Continued from page 24 preceding technical papers)

Dr. Lyle J. Swift
U. S. Citrus Products Sta.
Winter Haven, Fla.

Dr. Frank B. Thomas
Dept. of Food Tech.
Mass. Inst. of Tech.
Cambridge 39, Mass.

Dr. Tetsunosuke Yanagawa
Dept. of Chemistry
Doshisha University
Kyoto, Japan

Helen L. Xezones
513 Peebles St.
Pittsburgh 21, Pa.

STUDENTS

McDonald P. Benjamin
Univ. of Calif. Ch. No. 2
Davis, Calif.

Gary Brooks
362 Memorial Dr., Box 6250
Cambridge 39, Mass.

Charles Dame Jr.
326 Eye Street
Davis, Calif.

Dagmar Hnilica
Univ. of Calif., East Hall
Davis, Calif.

Robert E. Hughes, Jr.
2015 Taylor
Corvallis, Ore.

Frederick W. Knapp
111 G Street
Davis, Calif.

Donald D. Leethem
2925 Arthur St.
Corvallis, Ore.

Min E. Liu
106 C Street
Davis, Calif.

Edmund Lusas
Iowa State College
Dairy Industry Bldg.
Ames, Iowa

Charles J. Michel
5707 N. E. 28th
Portland 11, Ore.

Harold C. Nordan
2820 Orchard St.
Corvallis, Ore.

Harold L. Postlmayr
2162 Valentine St.
Los Angeles, Calif.

Walton H. Reeve
3165 Center St.
Salem, Ore.

John E. Schade
L-9 Aggie Villa
Davis, Calif.

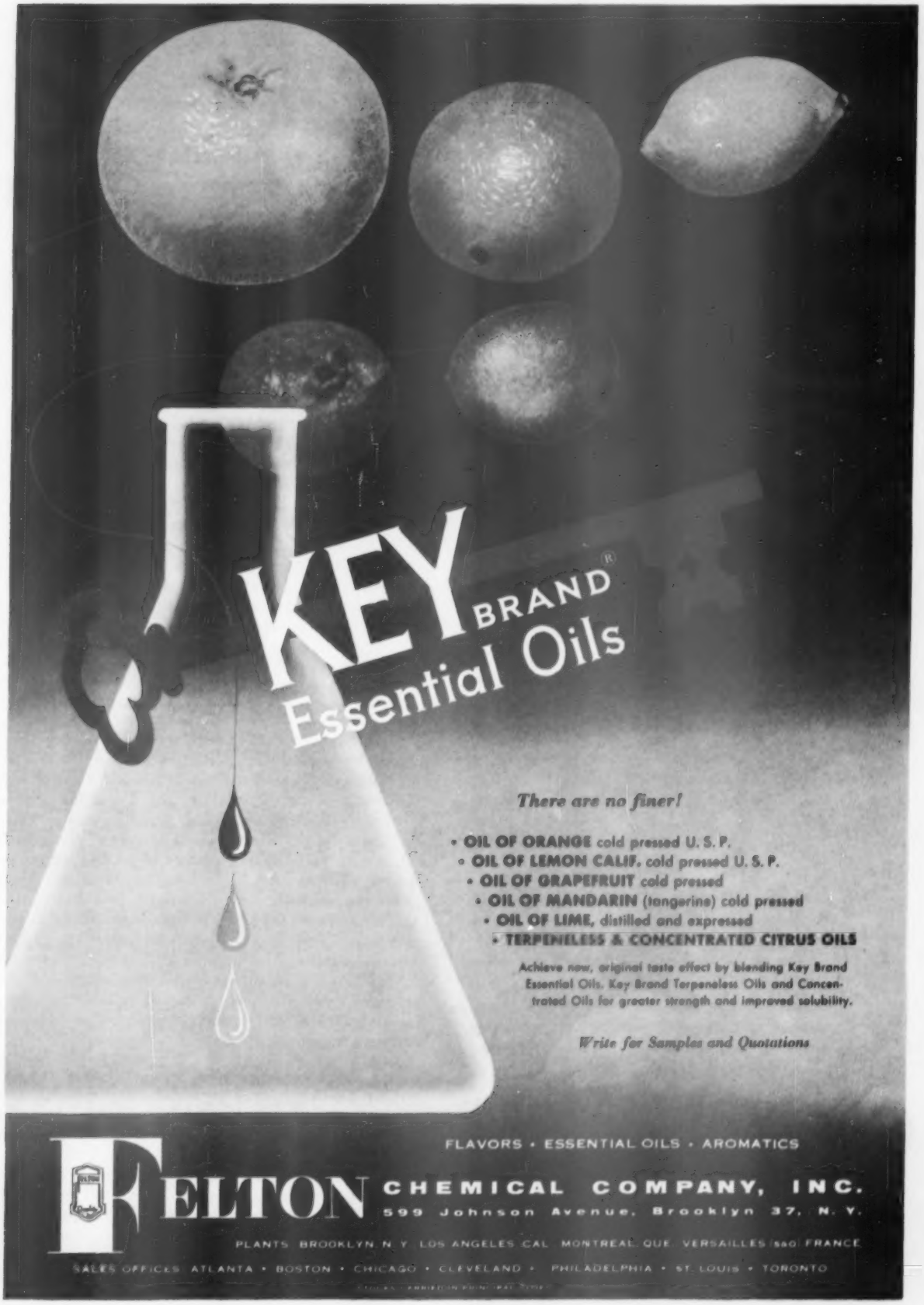
Jane Wentworth
Food & Nutrition Dept.
Florida State Univ.
Tallahassee, Fla.

## FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

**1955**

| | |
|---|---|
| February 14-18 | National Canners Association, Chicago, Ill. National Canners' Assocition, Chicago, Ill. |
| February 21-24 | International Food Show, New York, N. Y. |
| February 22-24 | Technical School for Pickle and Kraut Manufacturers, Kellog Center, Michigan State College, East Lansing, Michigan |
| March 7-10 | American Society of Bakery Engineers, Edgewater Beach Hotel, Chicago, Illinois |
| March 8, 9 | Third Annual Dairy Engineering Conference, Michigan State College, East Lansing, Michigan |
| March 13-17 | Frozen Food Industry Convention, Hotel Hilton, Chicago, Illinois |
| March 13-17 | National Association of Frozen Food Packers, Hotel Hilton, Chicago, Illinois |
| **March 18-19** | **Third Annual Food Technology Short Course, Memorial Student Union, University of Missouri, Columbia, Missouri** |
| March 29-30 | National Conference of Interstate Milk Shipments, Hotel Peabody, Memphis, Tennessee |
| March 29-April 7 | The 127th National Meeting of the American Chemical Society, Cincinnati, Ohio |
| May 15-19 | Annual Meeting of the Association of Cereal Chemists, Chase Hotel, St. Louis, Missouri |
| May 22-26 | International Bread Congress, Hamburg, Germany. |
| **June 12-16** | **Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio** |

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)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Essential Oils
There are no finer!
• OIL OF ORANGE cold pressed U. S. P.
• OIL OF LEMON CALIF. cold pressed U. S. P.
• OIL OF GRAPEFRUIT cold pressed
• OIL OF MANDARIN (tangerine) cold pressed
• OIL OF LIME, distilled and expressed
• TERPENELESS & CONCENTRATED CITRUS OILS
Achieve new, original taste effect by blending Key Brand Essential Oils, Key Brand Terpeneless Oils and Concentrated Oils for greater strength and improved solubility.
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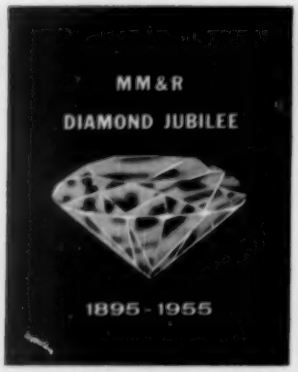
SALES OFFICES: ATLANTA • BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • ST. LOUIS • TORONTO




# *Partners in Progress*

The growth and development of *MM&R* span the six most momentous decades in the business and industrial life of America. During this period, the swift pace of discovery and invention remade the American way of life. Successfully meeting the challenging problems of expanding industries, *MM&R* advanced to a position of leadership in the world's essential oil markets.

Today, equipped with the most modern facilities for research and production, splendidly staffed, and sustained by long experience and vast international resources, *MM&R* is preeminently qualified to serve its customers in all parts of the world.

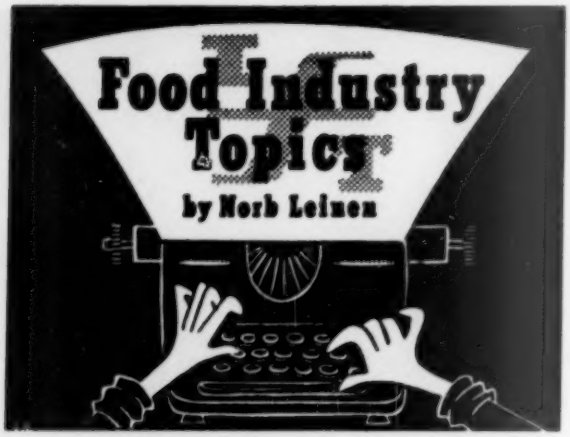
Customers made our business—customers will keep us in business. Their reliance on the resourcefulness and ingenuity of *MM&R* has been an important factor in the development and manufacture of many new fragrances and flavors to give greater sales appeal to their products. Such confidence and support, for which we are most grateful, made possible our Diamond Jubilee.

*Magnus Mabee & Reynard, Inc.* and its *customers* are indeed—*partners in progress.*

**MAGNUS, MABEE & REYNARD, INC.**

*One of the World's Greatest Suppliers of Essential Oils, Flavors and Basic Perfume Materials.*

16 DESBROSSES STREET, NEW YORK 13, NEW YORK
221 NORTH LASALLE STREET, CHICAGO 1, ILLINOIS


***. . . in the public interest***

By 1965, this country will be consuming products at double the present rate—with an available work force only 11% greater than today's—according to Mr. John J. Rudolf, supervisor of automation for Minneapolis-Honeywell Regulator Co. Increased productivity must keep pace with the expected rise in the non-working population resulting from higher birth rates, greater longevity, and earlier retirement. Higher production, lower costs, better products, and better utilization of space can result, Mr. Rudolf declared, from industry's application of one or both of two basic types of automation: (1) automatic manufacture of a single product in large quantities, and (2) manufacture of a number of different parts by a machine performing a variety of operations according to "instructions" fed into it by tapes or cards.

◆ ◆ ◆

Housewives who complain of today's higher food prices overlook advances in food preparation, packaging, and merchandising which account in part for prices, states an editorial in the December *Farm Journal* by Wheeler McMillen, editor-in-chief. "The term 'food dollar' is becoming inaccurate," the article points out, "now that grocery dollars buy so much 'built-in maid service.' Even so, an American wage earner has to work fewer hours to feed his family than do workers elsewhere. Efficient farming is the main reason, but we do have pretty efficient distribution. In Paris, an American businessman remarked that one good U.S. supermarket there could cut the consumer's food bill 20%. Sears & Roebuck's Latin-American stores have conspicuously reduced prices wherever they have opened."

◆ ◆ ◆

How progress is being made in solving some important food-processing problems of the South can be told from a listing of up-to-date developments in research under way by Southern Utilization Research Branch, Agricultural Research Service, USDA. Programs are in progress on citrus fruits, cucumbers, sweet potatoes, beets, tomatoes, black-eyed peas, rice, vegetable oils and fats, and sugarcane. The report is contained in the 1954 Annual Review Number of *Southern Food Processor.*

(Continued on page 34)

**Tom, that MORTON '999' sure has licked the problem of getting uniform salt flavor**

Yes, Morton '999' Salt is needed in canned meats to prevent quality variations. It should also be used by the makers and processors of candy . . . beer . . . canned foods . . . cereals . . . seasonings . . . pasta products . . . malted milk . . . mayonnaise . . . margarine . . . olives . . . sauerkraut.

## MORTON '999' SALT

**insures uniform quality**

in processed foods for two reasons. It's guaranteed to contain more than 99.9% pure sodium chloride — *always*. The 0.1% (or less) is a neutral inert sodium salt—never bitter calcium or magnesium compounds.

Vacuum pan evaporation guarantees that this salt will be clean . . . free flowing . . . evenly soluble. It has a constant weight per volume ratio . . . won't pack down.

## MORTON '999'

**the salt that carries its own guarantee**

**MAIL COUPON FOR FURTHER DETAILS TODAY!**

**MORTON SALT COMPANY**
Industrial Division, Dept. FT-2
120 So. La Salle St.
Chicago 3, Illinois

**I should like to receive—without obligation—more information on Morton '999' Salt and methods of using it in my product.**

Name_____

Title_____

Company_____

Address_____

City_____ State_____

## FOOD INDUSTRY TOPICS

(Continued from page 32)

New evidence of the metal can's many advantages for preserving food was revealed recently when a 63-year-old can of corn was opened and the contents found edible, reports Mr. T. P. Cobb, district sales manager of American Can Co. The corn was packed in 1891 by the Fredonia Canning and Mfg. Co. of Fredonia, N. Y., a subsidiary of the Ft. Stanwix Canning Co. of Rome. The old-fashioned hole-and-cap can with hand-soldered sideseams was made by Ginna and Co. of New York City more than a decade before American Can perfected the modern, open-end metal container, according to Mr. Cobb. A "coming out" ceremony was held in the offices of the New York State Canners and Freezers Assn., Rochester, N. Y.

◆ ◆ ◆

Judge Walter J. La Buy in U.S. District Court in Chicago ruled on December 3 that the Government's complaint in the so-called General Motors suit should be dismissed. "The Government," Judge La Buy said in the conclusion to his 220-page opinion, "has failed to prove conspiracy, monopolization, a restraint of trade, or any reasonable probability of a restraint, and for these reasons the Amended Complaint should be dismissed."

◆ ◆ ◆

Americans bought more groceries in 1954 than ever before and there is every indication the trends toward better eating and increased use of "convenience" foods are continuing, according to the year-end statement of Mr. Paul S. Willis, president of Grocery Manufacturers of America, Inc., 205 E. 42nd St., New York 17, N. Y. Abundant food supplies are in prospect for 1955, and it is estimated that per capita consumption will at least equal that of 1954. Supported by Government predictions for continuing high employment and consumer spending in the months ahead, the producers of familiar grocery store products are anticipating an approximate 5% sales gain over their record volume of 1954. Sales by grocery manufacturers this past year were about 4% ahead of 1953. At the retail level, sales by grocery and combination stores showed a 3% gain.

### . . . *things new under the sun*

Word of a **new series of Imitation Apple Flavors** in both liquid and crystal form has been received from Len Stoller of Givaudan Flavors Inc., 330 W.

(Continued on page 36)

*Announcing*

**A NEW COMPLETE CULTURE MEDIUM**

*Specifically designed for the luxuriant growth of all Lactic Acid Bacteria, Yeasts and Molds.*

**EXCHANGE BRAND ORANGE SERUM AGAR #77**
**(DEHYDRATED)**

Orange Serum Agar #77 assures an adequate supply of vitamins, amino acids and other organic compounds valuable for the stimulation of the rate of growth of microorganisms.

**LABORATORY PROVED**

**STANDARDIZED**

**FORTIFIED**—as a complete medium by fortification with yeast and meat hydrolysates, cysteine, etc.

**PROTECTED**—a special feature—contains an in-package desiccant.

**POTENTIAL USE**—as an all-purpose medium for a variety of bacteria, yeasts and fungi.

*Available through your laboratory supply house in 1-pound bottles.*

Exchange

PHARMACEUTICAL CITRUS PRODUCTS

**Sunkist Growers**

PRODUCTS DEPARTMENT
ONTARIO, CALIFORNIA

# HOWARD JOHNSON'S

## steps up Versatility of Retort Operation . . .

Operator at Howard Johnson's home plant in Wollaston, Mass. simply sets desired retort cooking program on the Foxboro Add-a-Unit sub-panel — flicks switch for automatic cycle. Controller at left regulates and charts temperature and pressure.

## . . . with Foxboro Automatic Add-a-Unit Control

Maintaining uniform, high product quality of more than 30 types of foods and sauces at Howard Johnson's, Wollaston, Mass., requires highly accurate retort control, readily adaptable to the various cooking schedules. This famous processing plant decided that the semi-automatic control they were using just wasn't flexible enough. A year ago, a fully automatic Foxboro Add-a-Unit Controller was installed.

The retort operator merely "dials" whatever control he needs — temperature, pressure, cooking time, start of cooling, cooling time, venting, draining. The Controller automatically carries out the desired cycle . . . duplicates it precisely whenever the same product is processed.

Add-a-Unit Control is completely adaptable to *your* requirements. First, install the basic Foxboro Retort Controller for temperature or temperature-and-pressure. Then, when you need them, additional control functions can be added in compact units — up to completely automatic operation. It's simple, accurate, economical. Write for details.

THE FOXBORO COMPANY, 352 NORFOLK ST., FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

Add-a-Unit
Retort Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

# You can have DRY AIR with exact moisture control..

*Assembling Electronic Parts*

**FOR YOUR COMFORT**

**FOR YOUR PROCESS**

**FOR TESTING MACHINES OR MATERIALS AT ANY TIME OF THE YEAR**

*Packaging Food Products*

● This Niagara "Controlled Humidity" method gives you the **MOST EFFECTIVE** Air Conditioning because its cooling and heating functions are made completely separate from adding or taking away moisture. This assures you always a precise result. No moisture sensitive instruments are needed.

*Drying Industrial Material*

**MOST FLEXIBLE.** You can reach and hold any condition in response to instrument settings, or vary it as you wish.

**EASIEST TO TAKE CARE OF.** The machine is accessible, the control circuits are simple and easy to operate, and there are no solids, salts or solutions to be handled.

**MOST COMPACT.** It does a very large amount of work in a small space.

**INEXPENSIVE TO OPERATE.** At normal atmospheric temperatures (unlike systems that use refrigeration to dehumidify) it needs no summer re-heat.

*Write for Bulletins 112 and 122*

## NIAGARA BLOWER COMPANY

Dept. FT, 405 Lexington Ave. New York 17, N. Y.

*Niagara District Engineers in Principal Cities of U. S. and Canada*


## FOOD INDUSTRY TOPICS

(Continued from page 34)

42nd. St., New York 36, N. Y. Stability and concentration make these flavors useful to food processors searching for an imitation apple flavor of the "modern" type—a flavor which has been growing more popular in such products as gelatine desserts, salads, ice pops, sherbets, hard candies, fondants, ice cream, etc. The crystal or "locked in" Imitation Apple Flavors, without any loss of character or quality inherent in the liquid products, also belong to the group of excellent flavor materials making up Givaudan's Permaseal Imitation Flavor Crystals. Samples and more detailed information may be obtained from the company.

◆ ◆ ◆

Tremendous speed of the new Raytheon "Radarange" oven is evidenced by cooking times required for various dishes. Mashed potatoes require an hour by conventional methods. By microwave cooking—three minutes. Fish filets are speeded up from 30 minutes to six minutes; baked apples from 40 to four minutes, and retain their natural color. Two commercial models of the "Radarange" are in production. Both are single-package systems housed in stainless steel cabinets. The larger, Model 1161, measures 26 x 26 x 64½ inches. The Model 1170, a counter unit, measures 23 x 21 x 29¾ inches. Write Raytheon Mfg. Co., Waltham 54, Mass.

◆ ◆ ◆

Powdered caramel color, a dehydrated food color made entirely from dextrose sugar by cooking under controlled conditions, is available from S. Twitchell Co., Crestmont & Haddon Aves., Camden 4, N. J. The product has particular use in dry food products including powdered desserts, dry cake mixes, powdered coffee, powdered gravy seasonings, dehydrated soups, and bouillon powders, where the use calls for a natural color ranging from a light to a very dark brown. The Twitchell Company was one of the pioneers in making extracts for the soft drinks bottling industry.

◆ ◆ ◆

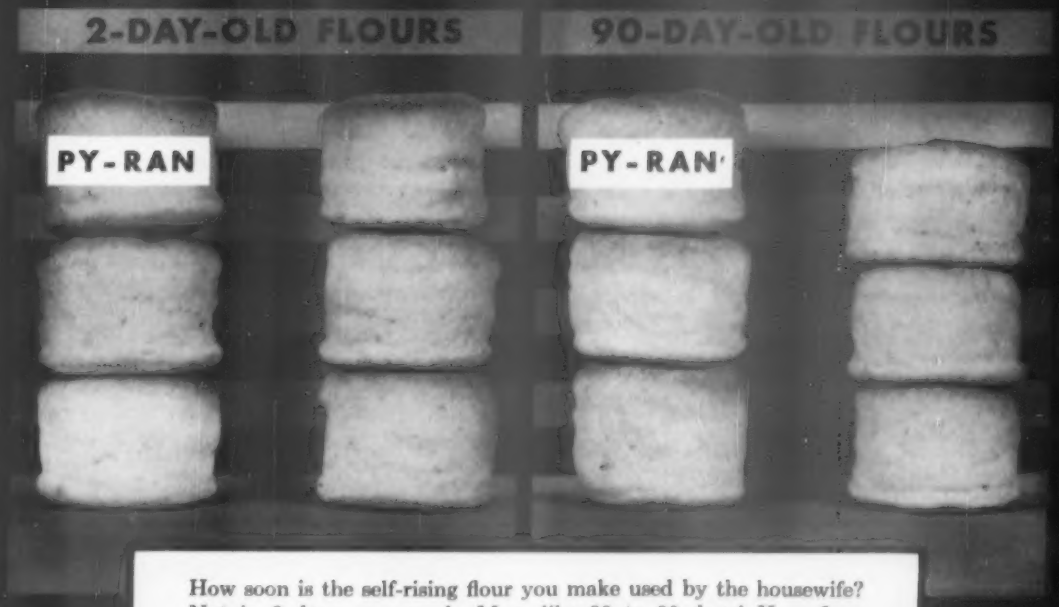
**High volume closing and tape-sealing of pre-filled polyethylene or cello bags** is the feature of a new machine, the FAS-TAPER, developed by J. H. Platt & Son, Los Angeles, Calif. Fed by a belt line of any desired length, the machine closes and gathers the necks of the filled bags, applies sealing tape, and releases the bag—all automatically. The system accommodates up to 120 bags per minute continuously throughout the working day. Comparison tests with hand-closing on cello-pack carrots have shown that a single operator with the machine replaces eight employees, saving labor costs of $75 per shift. Address inquiries to Byron H. Brown, 3719 Wilshire Blvd., Los Angeles 5, Calif.

◆ ◆ ◆

Lysine, an essential element in human nutrition and one in which many foods, notably those based on wheat, are deficient, is being made synthetically by the Du Pont Company in semi-commercial quantities. The firm's Electrochemicals Department has completed pilot plant facilities for producing L-lysine

(Continued on page 38)

# 90-day self-rising flour test proves PY-RAN* gives longer shelf life




How soon is the self-rising flour you make used by the housewife? Not in 2 days or a week. More like 30 to 90 days! Here flour leavened with PY-RAN and flour using another calcium phosphate give about equal results when 2 days old. But—when the flours are aged in a heatilator to equal 90 days of package life, only the PY-RAN flour performs like new. The other definitely loses its strength.

**PY-RAN'S MOISTURE-ABSORBENT COATING WARDS OFF TOO-EARLY REACTION.** Each granule of PY-RAN (monocalcium phosphate) has a moisture-absorbent coating to prevent too-early reaction. Result: longer shelf life for prepared mixes and self-rising flour—minimum of returned goods.

**MONSANTO'S PY-RAN HOLDS MAXIMUM LEAVENING ACTION FOR OVEN.** PY-RAN releases less $CO_2$ during the first two minutes of the mixing of the dough or batter. PY-RAN saves its leavening action for the oven.

**PY-RAN GIVES SUPERB TEXTURE, VOLUME, CRUST AND CRUMB COLOR.** PY-RAN blends perfectly with other leavening agents. Its slow controlled gas release gives excellent texture, volume, and crust and crumb color; almost no tunneling.

**MONSANTO OFFERS FULL LEAVENING LINE** including: SAPP-40 for machine doughnut mixes; SAPP-28, a slow-action baking acid; and HT* Phosphate (MCP monohydrate).

**FREE BOOKLET,** "MONSANTO PHOSPHATE LEAVENING AGENTS." Write: MONSANTO CHEMICAL COMPANY, Inorganic Chemicals Division, 710 North Twelfth Street, St. Louis 1, Missouri.

**LEAVENING SCHOOL FOR MONSANTO SALESMEN** so they can learn your business in order to help you. This is the only school of its type in the industry.

*Reg. U. S. Pat. Off.*

MONSANTO

SERVING INDUSTRY WHICH SERVES MANKIND

Leavening Phosphates From Monsanto Chemical Company

WORLD'S LARGEST PRODUCER OF ELEMENTAL PHOSPHORUS

## FOOD INDUSTRY TOPICS

(Continued from page 36)

monohydrochloride at its Niagara Falls, N. Y. plant. This is the naturally occurring form of lysine in which it is most easily assimilated by the body. The company has given the new product the trade-mark "Darvyl" and is making it available in limited quantities to food manufacturers, pharmaceutical houses, nutritionists, and research groups.

◆ ◆ ◆

**A new portable gas sampling unit,** the Model Y-101, has been added to the line of Arnold O. Beckman, Inc., 1020 S. Mission St., So. Pasadena, Calif. The unit provides a compact system for bringing sample gas streams to an analyzer for measurement. It consists of a motor-driven pump, filter, flow indicator, valves, and a 20-foot power cord, all mounted and interconnected in an aluminum case. The unit may be attached to a Beckman Model C2P Oxygen Analyzer (as illustrated) or supplied with a handle for independent operation. The pump operates on 115 Volt A.C. For further information write for Bulletin 704.

◆ ◆ ◆

A reliable, drift-free source of clean, dry air for instrument service or air-regulated equipment is provided by a **new adjustable output regulator** of Kendall Controls Corp., 144 Moody St., Waltham, Mass. The Model 55 Regulator has a flow capacity of up to 15 C.F.M., maximum inlet pressure of 150 lbs., and automatic relief if the regulated pressure exceeds the pre-set value. Unit is easily cleaned, and dripweli is drained by a simple pushbutton valve. Equipment manufacturers only may obtain a Model 55 for trial use at Kendall's expense. When requesting, use company letterhead and specify operating pressure range required.

◆ ◆ ◆

Latest addition to its line of Swagelok Tube Fittings—the **1/16" Capillary**—has been released by Crawford Fitting Co., 884 E. 140th St., Cleveland 10, O. Until now, tube fittings have not been available for capillary tubes in ranges of 1/16" because of difficulty in flaring small size tubing. The new Fitting has no flaring. No special tools are required for installation, nor is any preparatory work on the tube required. By slipping the capillary tubing into the fitting and turning the nut until a tight seal is secured, the installation is ready for operation. The 1/16" Fitting is available in brass, aluminum, steel, stainless steel, and Monel.

◆ ◆ ◆

**A permanent magnetic sweeper,** adaptable for three different uses, is offered by Cesco of Santa Rosa, Calif. With its road-type, pneumatic-tired wheels removed, the built-in carrier-hangers are utilized to mount the sweeper quickly and easily on any lift truck. Addition of these intermediate sizes to the existing manual and heavy-duty road sweepers gives Cesco the only complete line of sweepers for all purposes now offered. The sweeper is available in two models—Heavy Duty Power and Extra Heavy Duty Power—and in four sizes—2, 3, 4, and 5 foot effective sweeper widths. Write Cesco, Div. A62, Santa Rosa, Calif., and request Bulletin 415.

◆ ◆ ◆

Four new Dynamotive **gas powered electric transmission industrial trucks** were announced Dec. 20 by the Automatic Transportation Co., 149 W. 87th St., Chicago, Ill. Identical in design and engineering to the 4, 5, and 6,000 pound Dynamotive trucks introduced by Automatic early in 1953, the new models provide 7, 8, 9, and 10,000 pound capacities. Like the original Dynamotive, the new models are available with either standard gasoline or liquid propane (LP) engines, and can handle all attachments used by Automatic industrial trucks.

◆ ◆ ◆

Pecks Products Co., Suite 8, Brown Bldg., St. Louis 5, Mo., announces that all Pepco antiseptic hand cleansers are now made with Actamer, new bacteriostat for soap developed by Monsanto Chemical Co. for the positive control of dermatitis. The firm states that regular use of Pepco hand cleansers containing Actamer will reduce skin bacteria by as much as 97%, thus cutting absenteeism as well as eliminating most workman's compensation claims resulting from skin disorders. Complete information is offered in a brochure now available.

◆ ◆ ◆

The GS No. 41 **hair net visor,** for protection of women workers in industrial plants, is stated to be cool to wear and lightweight. It is adjustable to all head sizes, simplifying ordering and stocking. The green opaque visor eliminates glare from overhead lighting and reflection from shiny metals. Available in white, black, red, green, and maize. Price $3 per dozen. For complete information and trial order, write General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.

◆ ◆ ◆

**A new type of copy paper** that eliminates carbon paper has been brought out by The Pengad Companies, Pengad Bldg., Bayonne, N. J. AUTOSCRIPT combines the properties of carbon paper and ordinary second sheets. Placed in direct contact with the original copy, its specially processed finish enables it to reproduce sharply and legibly any impression. As many as 12 duplicate copies can be made. Advantages are 3-fold: (1) saves money because expensive carbon paper is eliminated and AUTOSCRIPT costs little more than ordinary copy paper; (2) saves much office time used in collating, sorting, and inserting carbon paper; (3) different colors allow short-cut office practices in routing, filing, checking, book-

(Continued on page 40)

# URGENT: To all frozen food processors

FX-1203

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

# WESTERN UNION

W. P. MARSHALL, PRESIDENT

SYMBOLS

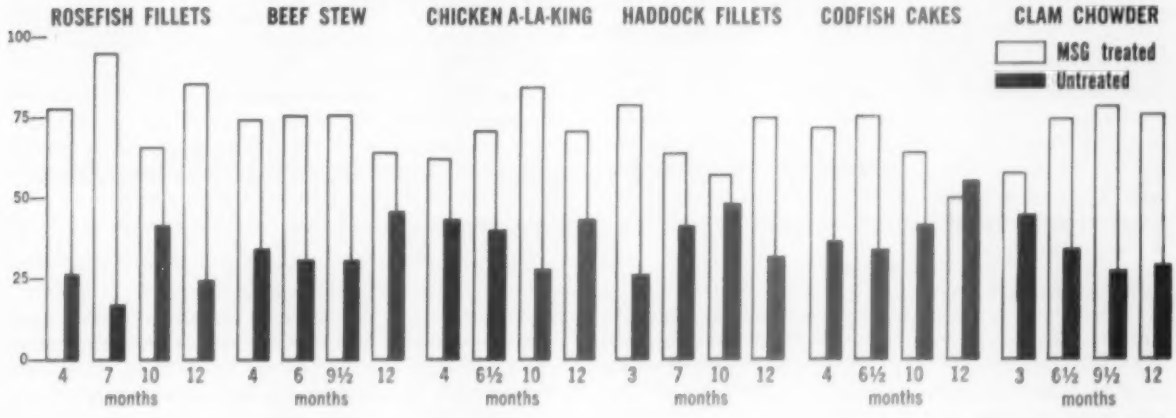
DL = Day Letter
NL = Night Letter
LT = Int'l Letter Telegram
VLT = Int'l Victory Ltr

The filing time shown in the date line on telegrams and day letters is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

WUN001 PD=NEW YORK NY JAN 6. 1955=

FLASHING YOU RESULTS OF 12-MONTH FLAVOR TEST OF MSG-TREATED FROZEN FOODS VS UNTREATED FOODS AT A LEADING UNIVERSITY* STOP 23 OF 24 TASTE TESTS SHOW MAJORITY OF TEST PANEL PREFERRED FLAVOR OF MSG-TREATED SAMPLES TO UNTREATED SAMPLES STOP. NOTE MORE THAN 2 TO 1 PREFERENCE IN 13 OF THESE TEST PERIODS STOP TEST ALSO REVEALED MOST EFFECTIVE USE-LEVELS FOR MSG STOP PROMISES NEW OUTLOOK FOR STORAGE AND WAREHOUSING PROBLEMS. HOLD-OR-SELL. AND PRODUCTION PEAKS AND VALLEYS STOP YOUR COPY FULL REPORT WAITING AT HURON TECHNICAL SERVICE. 9 PARK PLACE. NEW YORK 7. N. Y. STOP WRITE. WIRE OR PHONE TODAY STOP=

**Graphs show percent of test panel preference during 12 months' storage. Flavor tests conducted by university technicians.** *Name on request




B.4.10

# Huron MSG

PURE MONOSODIUM GLUTAMATE 99+%

**Made by the American pioneers in protein derivatives**

FACTORIES: Harbor Beach, Michigan

SALES OFFICES: 161 E. Grand Avenue, Chicago 11 • 607 Second National Building, Cincinnati 2 • 383 Brannan Street, San Francisco 7

## FOOD INDUSTRY TOPICS

(Continued from page 38)

keeping, and disbursing. Samples and prices available; dealer and manufacturer inquiries welcome. Write on company letterhead.

The four leading U.S. food markets, according to 1954 CONSUMER MARKETS reports, each went well over the billion dollar mark in 1953. New York (including N. E. New Jersey) led with $1,611,175,000 in retail food sales; Chicago ($1,678,068,000) and Los Angeles ($1,545,943,000) were second and third respectively, with Philadelphia running fourth with $1,120,915,000. In supermarket sales, the same cities were the top four in slightly different order: New York ($1,910,543,000), Los Angeles ($739,042,000), Chicago ($565,114,000), and Philadelphia ($431,772,000). Published annually, CONSUMER MARKETS is one of 11 publications of Standard Rate & Data Service. A limited number of copies of the 1954 edition, which also contains other valuable market information in its 700 pages, are available at $10 per copy from the publisher, 1740 Ridge Ave., Evanston, Ill.

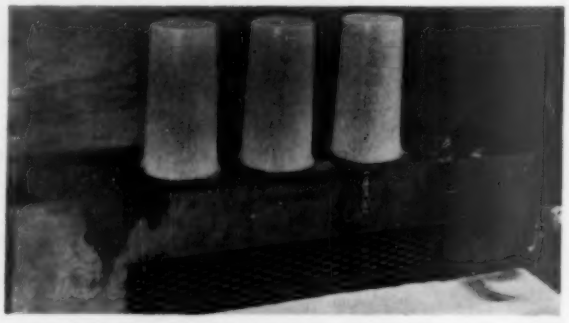
A filter designed to provide high efficiency filtering at low owning and operating cost and with a low pressure drop is announced by Cambridge Filter Corp., 738 Erie Blvd. E., Syracuse, N. Y. The Aerosolve Filter was developed for applications where the extreme efficiency of the Cambridge Absolute Filter is not required but where better than average air cleaning is desired. It is expected to find wide use in comfort air conditioning systems and for critical process air conditioning in chemical, pharmaceutical, and food processing industries where clean air is essential and where a high percentage of dusts or fumes must be kept from escaping.

A new Portable Masker is available from Permacel Tape Corp., New Brunswick, N. J. The P 7 L, which dispenses a 12-inch width of masking paper with masking tape aligned along one edge, can be modified into double or triple duty units by addition of Conversion Kits. The double duty unit can dispense both a 3 and a 9 inch apron, while the triple duty unit can handle a 12 inch width of paper plus 3 and 9 inch rolls.

Designed by aeronautical engineers, Wind Silencers reduce automobile wind-roar and noise to a gentle whisper, permitting enjoyment of the car radio and easy conversation at any speed. Made of strong, good-looking stainless steel and simple to install on any car, the units sell for $2.98 per pair postpaid and are guaranteed to please or money back. Order from American Homecraft Co., Box F.T., 3714 Milwaukee Ave., Chicago 41, Ill.

A long-standing problem—that of breakdown of cottage cheese curd because of addition of pineapple—has been solved by McCarthy Fruit Products Co., 1715 Church St., Evanston, Ill., and natural Hawaiian pineapple now can be blended with cottage cheese with assurance of long shelf-life. A leading Midwestern dairy found the product has three weeks of shelf-life under normal retail conditions. Starting as a Lenten feature, sales held up so well that the product became a year-round item.

A new stainless steel Rodney Hunt TURBA-FILM Evaporator concentrates, distills, deodorizes, degasses, deaerates, heats, cools, or otherwise processes liquids, gases, and slurries in a few seconds by continuous operation. Difficult, heat-sensitive, frothy, or heavy viscous materials can be processed in a single rapid pass, usually with no loss and in little floor space. The unit evaporates as much as 5,000 pounds of water per hour. It will handle organic and inorganic chemicals, solvents, latices, pharmaceutical "myeins," vitamins, juice concentrates, edible oils, gelatine, glues, confectionaries, coffee, and detergents. Write Rodney Hunt Machine Co., Orange, Mass.



**An ultrasonic emulsifying machine** manufactured by McKenna Laboratories, 2503 Main St., Santa Monica, Calif., produces a permanent emulsion of two or more liquids which would otherwise be difficult or impossible to mix together. Emulsifying action results from intense cavitation forces of focused ultrasonic waves which produce a state of fine division of one liquid into another. Division is in the lower-micron and sub-micron range which helps insure permanency and dilutability. Stabilizers which might alter the chemistry of the emulsion are either unnecessary or need only be used in much lesser quantity. The Model EM 750 produces a pure emulsion of oleic acid in water at the rate of four gallons per hour.

The new Placo Tank Rod Agitator has been introduced by Metal Finishing Mfg. Corp., 89 N. 11th St., Brooklyn 11, N. Y. The unit is fully insulated with bakelite arm and insulated rollers. It has ball-bearing stainless steel shaft rollers, ball-bearing gear box, V-belt drive to change speed, and an adjustable stroke up to 6 inches. It is easily mounted, clamps onto tank, has telescoping extended support, and 110 volt AC plug-in line and switch. The Agitator with single rod lists at $165; with double rod, $285.

**Complete, stainless steel conveyor roller ball bearings** which are sanitary, corrosion-resistant, and can be washed or steam cleaned repeatedly, have been developed for use in Ferguson gravity roller conveyors by the Harry J. Ferguson Co., Jenkintown, Pa. Ferguson conveyors meet special service condi-

(Continued on page 42)

# Celite Filtration assures perfect clarity—

## adds eye appeal and buy appeal to food products

TO GIVE foods and beverages that extra quality which results in more sales appeal, leading processors depend on Celite* Filtration.

The Celite method is *efficient.* It removes even the finest suspended solids. Moreover, Celite Filtration is *economical.* It may be used with any type of conventional filter, it is almost automatic, and skilled labor is not required for routine operation. And Celite Filtration is *flexible.* To meet your specific requirements, Celite comes in nine standard grades of microscopically controlled particle size. The right balance between degree of clarity and rate of flow may be easily controlled.

To purify water in large volume—to achieve brilliant clarity in many food products such as sugar, syrups, wine, beer, vegetable oils, cooking fats—to remove many colloidal impurities which may affect product quality . . . Celite Filtration offers unexcelled results.

A Johns-Manville Celite Filtration Engineer will gladly discuss the advantages and use of Celite in your product or production process. For his services, without obligation, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

**Johns-Manville CELITE** FILTER AND PRESSING AIDS

## FOOD INDUSTRY TOPICS

(Continued from page 40)

tions required in dairies, chemical plants, and food processing industries. By using various combinations of stainless steel, aluminum, or steel in both rollers and conveyor frames, different types of Ferguson anti-friction type gravity roller conveyors can be supplied to meet special operating conditions in other industries. The new bearings are available in conveyors in 2, 2¼, and 2½ inch diameter rollers.

◆ ◆ ◆

**An indicating controller in the low price range** for use on simple industrial processes has been designed by The Foxboro Co., Foxboro, Mass. Designated the Model 41A Pneumatic Controller, it replaces the earlier Model 41, providing short on-off or narrow band proportional control of such variables as temperature, pressure, liquid level, and humidity. As an economical temperature controller, the unit is used for blancher, exhaust box, and in-bottle pasteurizer control; also for control of product level in filler bowls.

◆ ◆ ◆

**A new portable high-intensity ultra-violet source** with important applications for detection of adulteration, impurities, spoilage, and filth in foods, containers, and related materials, is announced by Ultra-Violet Products, Inc., 145 Pasadena Ave., So. Pasadena, Calif. When directed at certain substances, the invisible "black light" rays cause fluorescence, whereby these substances radiate a color different from their own. Thus, many contaminating elements that are invisible, or nearly so, in ordinary white light, stand out clearly. This makes the lamps extremely useful for inspection, sorting, and analysis. When requesting information, please specify proposed application, giving full details, so pertinent data may be sent.

◆ ◆ ◆

**A new germicidal, all-purpose cleaner** for industrial and institutional use has been developed by West Disinfecting Co., 42-16 West St., Long Island City 1, N. Y. Called "Wescodyne," the product contains "tamed" iodine—chemically stabilized and retaining all the germicidal properties of iodine. It kills resistant varieties of bacteria and germs in minutes, yet the sting, irritant, and toxic properties have been reduced to a point where they are no longer a limiting factor in the usefulness of iodine as a germicide. The product, also a detergent, visually indicates its own germicidal activity. It is effective in warm and cold water, and hard water does not impair its action.

### . . . *the literary corner*

New Technical Data Sheet 28-84, published by Beckman Instruments, Inc., Fullerton 1, Calif., reveals how a spectrophotometric method proved so accurate in the analysis of vitamin $B_2$ content of distillery residues that the limiting factor became the sampling technique. This occurred in a nationally known distillery employing a Beckman DU Quartz Spectrophotometer with Fluorescence and Photomultiplier attachments. Savings in consumption of control materials brought about through use of the unit amortized its cost in six months. The intensity of the exciting light in this particular instrument was not great enough to cause any deterioration of the sample.

◆ ◆ ◆

New Bulletin 202 of Filtration Engineers, Inc., 155 Oraton St., Newark 4, N. J., describes FEinc horizontal rotary vacuum filters in sizes from three to 12 feet diameter. Recommended for coarse crystalline materials, fibrous pulps, and other free-settling or free-filtering applications, the filters are simple in design, with high capacity, fast de-watering, and excellent cake washing.

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**Glycerine Facts** for Dec. 15, 1954, issued by Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y., reports that a combination of mounting prices for cocoa beans and improvement in hard fat technology has resulted in a swing of candy manufacturers from standardized chocolate to "chocolate-type" coatings which may be made from higher fatty acids and glycerine. Contributing to this trend has been the incorporation of emulsifiers to improve stability and increase palatability. Among emulsifiers being investigated to solve the chief problem of users—gloss retention—are acetostearin, polyglyceryl stearate, sorbitan tristerate, and pure vacuum-distilled monoglycerides. This information was gleaned originally from *Food Engineering*, November, 1954.

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Evidence of the trend toward silicones is seen in the 1955 Reference Guide issued by Dow Corning Corp., Midland, Mich. Twice the size of last year's, the catalog lists 23 new products besides the 100-odd mentioned in 1954. Still retained is the "division by application" method of listing individual products which has been increased from 17 to 21 classifications. Write Mr. L. S. Putnam.

◆ ◆ ◆

Seventy-five questions and answers designed to help select and maintain stainless steel valves make up an unusual technical paper prepared by Cooper Alloy Corp., Hillside 5, N. J., from the questions raised at their valve clinics. The article covers selection of materials, data on new materials, service, and installation problems, as well as information on valve repair. Copies available.

◆ ◆ ◆

A new, more detailed publication on dispersion problems for chemical processes in industry is available through the Kinetic Dispersion Corp., 95 Botsford Pl., Buffalo, N. Y. The 48-page book contains comparison charts of results of various dispersion methods used in industry, and other technical data of

(Continued on page 44)

# Merck Vitamin A

*offers distinctive advantages in*

# Fortifying Margarine . . . . . .

*Purity of* MERCK VITAMIN A *is guaranteed by more than 100 quality-control tests applied to intermediates and the finished product.*

Margarine fortified with MERCK VITAMIN A ACETATE is free from off-odors or tastes. Continuous supplies of light-colored, stable Merck Vitamin A are assured by large plant capacity.

MERCK VITAMIN A ACETATE in vegetable oil is offered in batch size or bulk containers in a range of potencies. Our experience of two decades in the manufacture of vitamins is available to help you in the application of Vitamin A to your processes.

## Other Merck Products for the Food Industry:

| | | |
|---|---|---|
| ASCORBIC ACID | THIAMINE | TARTARIC ACID |
| CITRIC ACID | SODIUM CITRATE | SODIUM BENZOATE |
| RIBOFLAVIN | NIACIN | VITAMIN MIXTURES |

*Research and Production for the Nation's Health*

MERCK & CO., INC.
*Manufacturing Chemists*
RAHWAY, NEW JERSEY

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## FOOD INDUSTRY TOPICS

(Continued from page 42)

vital interest. A portion of the book consists of material from lectures of C. C. Candee, technical consultant, given at the University of North Dakota on the behavior of materials in solid, liquid, and dispersional phases. In addition, there is complete operational information on formulas for a number of Kady Mill coating materials.

◆ ◆ ◆

The growing applications of aluminum in the process industries are described in a new 8-page booklet published by Aluminum Company of America, 756 Alcoa Bldg., Pittsburgh 19, Pa. The brochure, "Aluminum in the Process Industries," outlines the economic and technical advantages of aluminum used in processing equipment for chemical and material storage, and for transporting liquids.

◆ ◆ ◆

A new 16-page catalog which gives a detailed description of performance, construction, specifications, accessories, and modifications on Model 11 and Model 14 Cary Recording Spectrophotometers is available from Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif. The Model 11 is for ultraviolet and visible spectra recording. The Model 14 covers ultraviolet, visible, and infrared regions. Also included is a brief description of features of other Cary instruments. Write for Bulletin P53.

◆ ◆ ◆

Full details of several recently announced Neptune Industrial Liquid Meters are given in new Bulletin 567 of Neptune Meter Co., 19 W. 50th St., New York 20, N. Y. Included are Auto-Stop quantity control meters, Auto-Switch meters which actuate an electrical switch when the desired quantity has been metered, Print-O-Meters which aid quality and inventory control by providing printed tickets for each delivery or batch, and meters with simple direct reading registers. Of particular importance to process engineers is a chart which helps in selection of proper size and type of meter for any given application. Included is a list of nearly 150 common chemicals and liquid ingredients now being metered successfully with Neptune Type S meters.

◆ ◆ ◆

New services offered by Foster D. Snell, Inc.—described in their new eight-page illustrated booklet, "Assay for Vitamin D"—permit rapid, economical, and accurate vitamin D assays conducted according to U.S.P. requirements. The booklet lists prices for single and multiple samples for vitamin D determinations. Samples can be assayed and reports mailed within eight days. Write Public Relations Dept., Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

◆ ◆ ◆

A four-page circular describing "Luncor," the first all-molded PVC valve and fittings, has been published by The Lunkenheimer Co., Box 360, Cincinnati 14, O. The "Luncor" valve and fittings have remarkable resistance to corrosive chemical action and resist most chemicals used in industry. The exclusive molding process gives the PVC material exceptional strength, protects its natural corrosion-resistance, and substantially reduces manufacturing costs.

◆ ◆ ◆

An eight-page booklet which combines description and illustrations of various types of Fiberglass Aerocor Insulation is available from Owens-Corning Fiberglass Corp., 1019 Spitzer Bldg., Toledo 4, O. These products have a low thermal conductivity and high sound absorption qualities, yet are light in weight, non-combustible, clean, and easy to handle. Aerocor, a soft, resilient, blanket-type insulation, is produced by Owens-Corning, in various sizes for special uses. Write any of Owens-Corning's 63 sales offices or the general offices in Toledo.

◆ ◆ ◆

How colloidal dispersions have been used successfully for dry-film lubrication is described in illustrated bulletin No. 438, published by Acheson Colloids Co., Port Huron, Mich. Technical advances have demanded the improved lubricating properties provided by such solids as electric-furnace graphite, molybdenum disulfide, zinc oxide, and mica. Processed to colloidal size and dispersed in synthetic oils, glycols, mineral spirits, lactol spirits, synthetic resins, and other liquid carriers, these solids produce desirable dry-film lubricating films extremely effective over a wide operating range. The dry film consists of a micro-thin layer of graphite particles left on the surface to be lubricated after the volatile carrier has evaporated. Various combinations of lubricating solids and carriers and their specific application in various manufacturing processes are presented.

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The latest catalog of Florasynth Laboratories, Inc., listing details of products and suggested usages, will interest manufacturers of foods, confectionery, beverages, cosmetics, soap, pharmaceuticals, extracts, and industries using flavorings, perfume compounds, aromatic chemicals, and essential oils. Manufacturers who may not have received their copy are invited to write on their letterhead to Florasynth Laboratories, Inc., 900 Van Nest Ave., New York 62, N. Y., or to any Florasynth U.S. branch office, or to one of the foreign affiliates in Mexico, Canada, or South America.

### . . . *building up and branching out*

An animated, full-color motion picture is planned by Continental Can Co., 100 E. 42nd St., New York 17, N. Y., as part of its continuing program to promote sale of canned foods at the retail level. Transfilm, Inc., will produce the 15-minute film, which will be ready for showing on April 1, 1955, and will highlight to grocers the merchandising opportunities inherent in canned foods. The film is designed for presentation at conventions and meetings of all levels of the food retailing and canning industries.

◆ ◆ ◆

Johns-Manville is now co-sponsoring the well-known half-hour Sunday television program, "Meet the Press," over 26 stations on a coast-to-coast NBC

(Continued on page 46)

# PROTOVANOL "C"

an AMAZINGLY EFFECTIVE REPLACEMENT FOR COUMARIN . .

PROTOVANOL "C" is at least 50% stronger in flavoring strength than Coumarin Fine Crystals, is fully soluble in alcohol, propylene, and to an extent even in vegetable oils . . . PROTOVANOL "C" has amazing versatility readily mixed in various dry bases . . . and easily absorbed in cane sugar, corn sugar or starch . . .

Florasynth LABORATORIES, INC.

CHICAGO 6 • NEW YORK 62 • LOS ANGELES 21

CINCINNATI 2 • DETROIT • DALLAS • MEMPHIS • NEW ORLEANS 12
ST. LOUIS 2 • SAN FRANCISCO • SAN BERNARDINO
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PRODUCTOS Y LABORATORIOS FLORASYNTH, S.A. MEXICO 11, D.F.

## PURE VANILLA CONCENTRATE
## VERITAS

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PRODUCTOS Y LABORATORIOS FLORASYNTH, S.A. MEXICO 11, D.F.

# A Guide to a Better Beginning!

Florasynth's Entrapped Powdered Flavors keep the flavor characteristics so alive, so fresh . . . provide instant solubility in cold water . . . complete dispersability within the mix . . . definitely longer shelf-life. Available for prompt shipment in wide flavor selection . . .

*Samples available . . . or for your particular requirement . . . upon request . . .*

**FLORASYNTH LABORATORIES, INC.**

# Artificial GARLIC OIL

A Remarkable Reproduction . . .
At A Remarkably Low Cost . .

Florasynth LABORATORIES, INC.

CHICAGO 6 NEW YORK 62 LOS ANGELES 21
Cincinnati 2 • Detroit • • Dallas • Memphis • New Orleans 12
St. Louis 2 • San Francisco • San Bernardino
Florasynth Labs. (Canada Ltd.) • Montreal, Toronto, Vancouver, Winnipeg
Productos y Laboratorios Florasynth, S.A. Mexico 11, D.F.

## FOOD INDUSTRY TOPICS

(Continued from page 44)

network. The program, broadcast each Sunday continuously since 1948 according to Mr. H. M. Shackelford, vice president in charge of sales, has won nearly every award in the public service field, including the coveted Peabody Award.

◆ ◆ ◆

At the annual sales conference of Fritzsche Brothers, Inc., New York City, held in December, out-of-town representatives were shown the firm's recently acquired facilities which take in 20,000 additional sq. ft. of floor space on the 13th floor of the Port Authority Bldg. The entire Perfume and Technical Division with its personnel and four modern new laboratories has been transferred to the new location, along with several other departments.

◆ ◆ ◆

Merco Centrifugal Co., San Francisco, Calif., has opened a new office in Chicago Heights, Ill., to serve the food and chemical processing companies in the Midwest. Mr. Karl P. Hetzler has been appointed sales representative in charge of the Chicago office.

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To provide better service in an 11-state area of the Southeast, Distillation Products Industries of Eastman Kodak Co. opened a new sales office at 1388 Madison St., Memphis 4, Tenn., on January 3. The office, managed by Mr. John F. Hanrahan, will help handle increased business in all of the division's product lines, especially of distilled monoglycerides for use in the baking and cosmetic fields. The office will also serve in sales of vitamin A used by margarine manufacturers and in pharmaceutical fields, and of vitamin E which is finding increasing use in animal feed supplements and in pharmaceuticals.

◆ ◆ ◆

Grace Machinery Co., Oakland, Calif., makers of cottage cheese mixing, blending, and curd-handling equipment, announces appointment of Manton-Gaulin Mfg. Co., Inc., Everett, Mass., as sales distributor for Grace products in the East, Midwest, and South.

◆ ◆ ◆

All overseas sales activities of F. J. Stokes Machine Co. are now administered and controlled by a new International Division established at the company's headquarters, 5500 Tabor Rd., Philadelphia 20, Pa. While Stokes' sales will be handled through local representatives throughout the world, the International Division will enable the firm to establish closer control over and better relations with these representatives and thus give better service to its overseas customers. The Division is directed by Mr. Chas. W. Nicholson.

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With the opening of the Transparent Package Company's plant in San Francisco on Dec. 1, the firm became the first manufacturer of cellulose and plastic film casing for meats and other food products to operate a plant west of Chicago. "Tee-Pak" feels that San Francisco is the logical location for the plant, as it is the center of the billion dollar plus western meat industry. Mr. Gordon Cummings has been named western manager.

### . . . *meeting hall and conference room*

Emphasis on a fully rounded homelife and its efficient management is the theme of the California Home Economics Assn.'s Fifth Biennial Convention and its accompanying exhibition of household equipment, supplies, and gadgets to be held at the Los Angeles Ambassador Hotel, April 2, 3, 4, 1955, it was disclosed by Miss Mercedes Bates, association president. The meet will be regional in effect, as the Home Economics Associations of the adjoining western states have been invited to attend. The Exhibition is under the management of Lykke-Wilkin & Associates, 681 Market St., San Francisco.

◆ ◆ ◆

Solicitations from all types of industries from nearly every Western state and from Eastern manufacturers of raw plastics and plastics equipment and machinery, from England and European countries, and from as far away as Australia have reportedly poured into headquarters of the forthcoming World Plastics Fair and Trade Exposition, 8762 Holloway Dr., Los Angeles 46, Calif. The Exposition is designed to help bring demand and supply together—to come up with the right answers to problems of material application, tools, dies, molds, machinery, engineering, etc. Write above address for dates.

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Pictured are executives and sales representatives of Ungerer & Company, Inc., New York flavor house, in attendance at the firm's annual sales meeting, held in part at the New York City headquarters, and in part at the recently enlarged Laboratory and plant at Totowa, N. J., Nov. 15, 16, 17, and 18, 1954. From left to right—W. A. Bush, secretary; G. R. MacDonand; N. E. Gallagher; F. R. Schumm; J. R. Martin; Dr. Althausen (IFT member); F. M. Miller; W. E. Kell; F. H. Ungerer, board chairman; E. C. Dohrmann; A. G. Young; K. G. Voorhees, president; I. H. Budd, vice president; Henry Budd; S. Goodwillie, general sales mgr.; W. H. Dunney, vice president; Ira Bennet; J. L. Slais.

◆ ◆ ◆

Some 30,000 business executives from the U.S. and foreign countries are expected to attend the American Management Assn.'s 24th National Packaging Exposition, market place of the $10-billion-a-year packaging industry. The show, to be held April 18-21 in Chicago's International Amphitheatre, will set records for attendance, area, and number of exhibitors, spokesmen for the A.M.A. predict. An accompanying A.M.A. Packaging Conference will sum up trends in both the technical and merchandising aspects of packaging. For further information write A.M.A., 330 W. 42nd St., New York 36, N. Y.

***. . . the human element***

Assignment of **Eugene E. Rhodes,** assistant treasurer, as acting manager of the soybean division has been announced by the A. E. Staley Mfg. Co., Decatur, Ill., corn and soybean processor. The Staley Soybean Division is made up of the refined oil, crude oil, meal, and formula feed sales departments. Mr. Rhodes recently supervised establishment of the Indiana division of the formula feed department after the Staley Company in August purchased the livestock and poultry feed business of the Glidden Co.

Mr. Sheldon Y. Carnes, vice president and general sales manager, Arkell & Smiths, manufacturers of multiwall and specialty bags, has announced appointment of **Mr. W. H. Barrows** as New England District Manager. With the recent acquisition of a fourth bag-making plant at Hudson Falls, N. Y., and addition of equipment to the Canajoharie plant, A&S offers its complete line of bags to the New England area. Mr. Barrows will headquarter in the Statler Office Bldg., Boston, Mass.

**Mr. Guy G. Van Patten,** a charter member of Hoffmann-La Roche's Vitamin Division field staff, retired Dec. 1, 1954. His former responsibilities in the Minneapolis, Iowa, and Chicago areas have been allocated to **Mr. H. Gilmore Walter, Mr. J. C. ("Bud") Lamping, Jr.,** and **Mr. Stanley T. Olds,** respectively, who will also continue to handle their previously assigned territories. Mr. Van Patten has announced he will devote his energies to the Van Patten Service Laboratories, to be established under the direction of Mrs. Van Patten in Chandler, Ariz.

**Mr. Robert B. Magnus,** vice president of Magnus, Mabee & Reynard, Inc., international essential oil firm, was re-elected vice president of the New York Board of Trade, Inc., Dec. 15, 1954. Mr. Magnus has served as a member of the organization's Board of Directors and Executive Committee, holding the offices of assistant treasurer and treasurer. He is also an active member of the Executive Committee of the Drug, Chemical and Allied Trade Section, of which he has been treasurer, vice chairman, and chairman.

National Dairy Research Laboratories, Inc., Oakdale, Long Island, N. Y., announces appointment of **Mr. Neil E. Sullivan** to the Engineering staff.

Atlas Powder Company, Wilmington, Del., announces that **Dr. J. Peter Kass** has resigned as research director. However, Dr. Kass, an IFT member, will continue to serve as a special consultant on the company's food research program. **Dr. Robert S. Rose, Jr.,** now associate research director, has been named acting research director.

**SANITATION**
starts with
**IN-PLANT CHLORINATION**

**From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:**

**Eliminating slime formation on equipment and in work areas**

**Retarding bacteria growth**

**Greatly reducing offensive odors**

**For information on how In-Plant Chlorination can help solve *your* sanitation problems, write today to our Foods Division.**

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## Advertisers' Index


| | Page |
|---|---|
| Ass'n of American Soap & Glycerine Producers | 3rd Cover |
| Abbott Laboratories | 3 |
| Atlas Powder Company | 2nd Cover |
| Beckman Instruments, Inc. | 27 |
| Diamond Crystal Salt Company | 30 |
| Distillation Products Industries | 14-15 |
| Felton Chemical Company Inc. | 31 |
| Firmenich, Inc. | 17 |
| Florasynth Laboratories Inc. | 45 |
| Food Development Laboratory | 48 |
| Food Machinery & Chemical Corporation | 23 |
| Food Research Laboratories Inc. | 48 |
| The Foxboro Company | 35 |
| Fritzsche Brothers, Inc. | 11 |
| Givaudan Flavors Inc. | 26 |
| Griffith Laboratories Inc. | 25 |
| Hoffmann-La Roche Inc. | 4 |
| Huron Milling Company | 39 |
| Johns-Manville Corporation | 41 |
| LaWall & Harrisson | 48 |
| Magnus, Mabee & Reynard, Inc. | 32 |
| Merck & Company, Inc. | 43 |
| Monsanto Chemical Company | 37 |
| Morton Salt Company | 33 |
| Neumann-Buslee & Wolfe, Inc. | 9 |
| Niagara Blower Company | 36 |
| Norda Essential Oil & Chemical | 4th Cover |
| The Pfaudler Company | 1 |
| Chas. Pfizer & Company, Inc. | 7 |
| A. E. Staley Mfg. Co. | 48 |
| Wm. J. Stange | 19 |
| Sterwin Chemicals Inc. | 29 |
| Sunkist Growers, Inc. | 21 and 34 |
| van Ameringen-Haebler, Inc. | 13 |
| Wallace & Tiernan Company, Inc. | 47 |
| Wisconsin Alumni Foundation | 48 |

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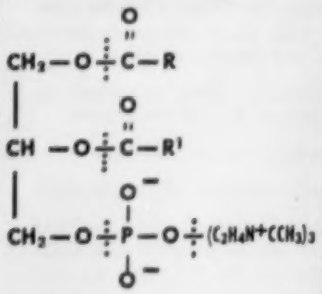

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Reply Box No. 385, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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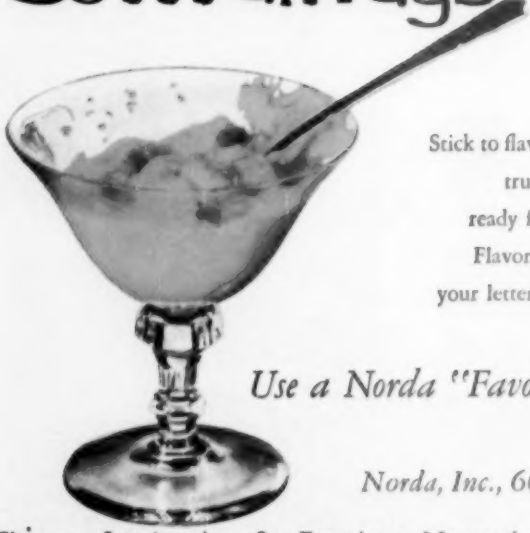

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